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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Where Designers Fail.

It is often the case, nowadays, that castings for the same object are made in metals of very different physical properties. In modern foundry work, abroad and at home, novel metals and alloys are coming into more general use. As an example there are parts of the internal combustion engine which have, in the past, been made in cast iron as a general practice. These parts are now quite frequently cast in one of the various light alloys.

Taking into consideration the wide differences between the melting points of these alloys and that of cast iron, it would be unreasonable to expect that methods which are used in the melting of iron would be suitable to apply to the melting of light alloys; even if the chemical behaviour of these metals in the molten state would allow of this uniform application. Moreover, no one could consider that a foundry designed expressly to cope with the lighter metal could be a convenient one in which to manipulate molten masses of the heavier.

The manufacturer realises this, and, in consequence, only calls upon his foundry to produce castings in the particular metals and alloys for the production of which his foundry has been laid out.

The designer does not always realise, however, that a pattern and a core box that has been used with success in the production of a casting in iron is not necessarily suitable, in fact, is almost certain not to be suitable, for use in an aluminium foundry. Similarly, it is extremely probable that if the casting has been made regularly in aluminium alloy, before a successful and useful casting can be made in magnesium alloy, the pattern will require modification. Similar modification would probably have to be made in permanent chill moulds and dies.

The manufacturer of motor-car and motor-bicycle engines is always searching to incorporate into his engine some new idea that will have a beneficial effect upon his engine's performance. He may, for example, have been in the habit of using cast-iron pistons as a standard. He feels he would like sets of pistons in aluminium alloy, and in magnesium alloy to fit into his engine for trial. He gets into touch with those who deal in these metals. He probably sends them copies of the patterns used in the iron foundry from which he has been obtaining the pistons, or possibly he sends drawings of the pistons. A great delay follows, very much to the manufacturer's disappointment and inconvenience. The pistons have practically to be re-designed, following only the exterior dimensions, and as closely as possible, the main idea of the original.

This is not solely due to the fact that the founder is dealing, in the case of aluminium alloy, with a metal of considerably less than one-half the density of molten iron, and in the case of magnesium alloy with a metal of about one-quarter the weight of molten iron. This re-design is made necessary by the recognition of differences in other physical properties than density, and from considerations other than purely hydrostatic.

By the alteration of the dimensions of the detail in the design of the piston (since that is the example selected) the fullest advantage can be taken of those superior physical properties for which the particular light alloy has been advocated. To illustrate this point it may be mentioned that many light alloys are more than 200 per cent. better conductors of heat than cast iron. They are at least as strong as cast iron at ordinary atmospheric temperatures, but not quite so strong at temperatures which might occasionally be met with in working conditions in an ordinary internal-combustion engine. The head, webs and walls of the piston can be thickened to counteract the falling off in strength, and still the weight of the piston will be considerably less than that of the similar cast-iron piston. It is obvious that, as redesigned, it will have greater capacity for heat conduction than before, enabling the engine to "run" cooler. The illustration which has been cited is a single case. It is intended to emphasise the necessity for the most careful consideration, both on the point of the designer and the foundryman, of the properties of the metal or alloy with which they are dealing. For the designer, in that his design should take the fullest possible advantage of the properties of his metal, and the foundryman, that methods suitable for the casting of one alloy are not of necessity suitable for any other.

In considering magnesium, the statement recently made in the daily Press, and attributed to an eminent metallurgist, to the effect that it is inflammable, will carry no weight with foundrymen who have seen the molten metal cast and have examined parts that have stood up in practice over long periods.

A Few Notes on Inspection.

A foundry foreman receiving a message stating approximately that Mr. "Smith" will call to inspect certain castings, is often heard to say that he wished they were sending somebody-else instead. Obviously the man coming is not welcome because he is too strict and frequently unversed in the art of producing castings. On the other hand, it often happens that a firm will send along one of their draughtsmen to inspect castings, and usually they select the man who can best be spared at the particular time, irrespective of his ability thoroughly to carry out the necessary inspection.

This, of course, only goes to show that iron castings are still viewed by a number of purchasers as being a necessary evil in their particular work, but not nearly as important as steel shafting, etc.

This view will in time become quite defunct, as the foundryman is bringing to light the value of his knowledge in a manner which will not allow of contradiction.

When this time arrives and the foundryman can produce a repetition of continuous good work, as a result of increased technical research, is it possible the inspection side will be neglected, or are foundrymen utilising a material which provides no distinct basis?

It often happens in the foundry that after the moulder has made a casting with the greatest care and under the personal supervision of the shop superintendent that some fault is discovered when the casting is dressed. If the inspector is permanently fixed at the works such a casting would be put up to him immediately for permission to to rectify the fault either by "burning" or welding as the case may be.

If it happens that an unpopular inspector is sent along specially, it is quite likely the fault will be attended to before his arrival, trusting that he will miss it during inspection, as the foundry people know his lack of practical ability; and yet will not draw his attention to the mend owing to his strict decisions, and fear of rejection.

An inspector of castings need not necessarily be a moulder, but he certainly should have considerable knowledge of foundry practice. To appreciate the full value of a casting he should first of all be an engineer able to understand the conditions the casting will be subjected to when in work. He should have a fair knowledge of cupola melting, of moulding—green and dry sand and loam— and where to look for faults according to the manner of moulding the casting. The various places on the casting which call for special attention under working conditions he should keenly observe. Such an Inspector can be approached with confidence by the foundry staff when in difficulty, and he would do his utmost to save an expensive casting. Further, few firms would have the temerity to try any bluff or secret mending on work for such an Inspector, and would respect his ability. The difficulty arises when an Inspector, having such ability, hides his "light under a bushel," and a variety of foundry sleight-of-hand tricks are performed. The position becomes rather desperate at times, until his ability becomes general knowledge amongst those concerned.

It is only then that the Inspector can discard the tact which he must certainly possess to cope with the initial difficulties at a place of manufacture not previously visited. The question arises:—"Why should such an Inspector be familiar with moulding, etc.?" Of course, given a drawing, it is an easy matter to check a casting. But without foundry knowledge it is a difficult matter to sympathise with the shop superintendents' "bad luck," not knowing even whether his statements have passed through the same vein of "bad luck" to their detriment.

A case in point came under the writer's notice recently where an Inspector saw transverse test bars 2 in. × 1 in. × 36 in. removed from the mould at a dull red heat and quenched in water. When he resented this treatment, he was calmly told by the shop superintendent they wished to cool the bars quickly and wash the sand off them.

The Application of the Proposed Regulations for Cleaning Castings.

We are sorry to note from Mr. Slingsby's letter, printed elsewhere, that he finds himself in disagreement with the sentiments expressed in the leader of our issue of July 12, and perhaps this is due to our insufficiently emphasising the importance of the medical aspect of the cleaning of castings as set out in the Home Office Report. We feel sure that an intensive consideration of the Report, *always bearing in mind health desiderata*, would convince Mr. Slingsby that, even if *extra cost* is entailed, it is worth while. It is often found that the imposition of reasonable factory regulations make for efficiency and cheaper production. This factor was emphasised during the recent heat wave, when several firms noted that the works efficiency decreased between 10 and 25 per cent. This strikes at the very root of the question, that the further removed working conditions are from ideal, the greater the inefficiency of the employees. Some firms state definitely that a welfare department, which implies expenditure beyond that required by the Home Office Regulations, pays handsomely.

Dealing *seriatim* with Mr. Slingsby's objections, the statement in his second paragraph, that several of the Regulations are useless, remains unsupported, whilst the *proposed Regulations* are supported by medical evidence. "Too much power is given to inspectors" is purely a matter of opinion, as we are only too familiar with the "converted-house" type of foundry, which are real death-traps. They have but small overhead expenses, often associated with a defective system of costing, such as doing all work for one engineering firm at a definite rate per cwt., which allows them to compete with firms who try to make foundries fit for moulders to work in, amongst which class we are sure we can include Mr. Slingsby's foundry.

If, of course, the imposition of the proposed Regulations does cause costs to be increased by 200 to 300 per cent., obviously the gain sought would be lost, as it might involve the closing of many foundries; and then it would be cheaper to import, and would defeat its object, as men are better in health when employed even in relatively unhealthy foundries than drawing the dole.

The object in giving prominence to the subject was to enable foundry owners a chance to study the practical application of the proposed Regulations, as the procedure in these cases is for the Home Secretary to publish a final draft and to ask for objections to be made within a definite period. If any objections appear to be serious, then a representative meeting is called and an effort is made to come to an agreement by making various amendments. If agreement cannot be reached, then evidence is taken on commission before a Judge or eminent Barrister-at-Law, and he, according to his judgment, amends the Regulations. This appears a very reasonable mode of procedure, as it presents, if necessary, a double opportunity for examination of the practical application in detail.

The rusting of castings is a point we certainly had overlooked, and the views of other foundry owners would be welcomed on this point.

The economic aspects of Mr. Slingsby's last paragraph are distinctly contentious, and at the moment remote; if the proposed Regulations are so drastic, they will never be allowed to be applied.

Personal.

MR. S. SPRINGER, who has been assistant director of the Federation of British Industries since 1920, is leaving the service of the Federation.

DR. W. RIPPER has had the title of Emeritus Professor of Mechanical Engineering conferred upon him by the University of Sheffield in recognition of the services he has rendered to the Department of Engineering and to the University.

THE RIGHT HON. SIR ALFRED MOND, BART., M.P., has rejoined the board of the Mond Nickel Company, Limited, and has accepted the chairmanship of the company in place of Mr. Robert Mond, who has resigned from that position. The directors have elected Messrs. D. Owen Evans, Carl Langer, jun., Henry Mond and Philip Mond directors of the company.

The Sand-Throwing Method of Moulding.*

By Daniel Sharpe.

In introducing the subject of moulding by the sand-throwing system, the Author appreciates that he is laying before many members of the Institution a method of moulding on which very little public information has been given, and also raising a matter of discussion as to efficiency. Many attempts have been made to obtain the production of moulds by the throwing of sand directly into the moulding box. The records of the Patent Office, both in America and in this country, very clearly show that a large number of inventors have seen the value of such a process and have applied themselves in an attempt to master the many difficulties of producing satisfactory moulds in this manner.

Early Attempts.

The writer has seen in America a very elementary application of the sand-throwing system, which consisted of a grab bucket filled with sand being dumped directly over a large shallow mould; the

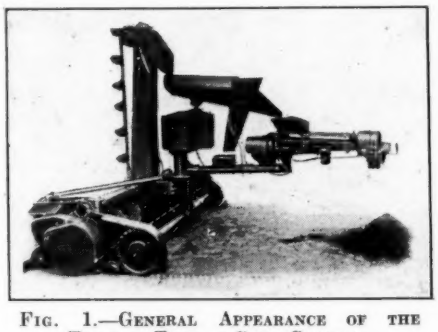

FIG. 1.—GENERAL APPEARANCE OF THE TRACTOR TYPE OF SAND SLINGER.

surface sand was scraped off and the top of the box dog-rammed before the part was removed from the pattern. This method, of course, is only applicable in very exceptional cases. Sand-dropping machines have been working in Glasgow, using a principle of dropping sand from a height on to a moving platform on which was mounted a pattern and moulding box. The speed of production was very slow, and there was no means of controlling the ramming to produce hard or soft effects, and only moulds which required very light ramming could be produced.

Some of the inventions recorded include the use of compressed air to shoot the sand into the mould. The great difficulty, however, is to get rid of the compressed air, which has the action of rebounding and destroying the ramming effect of the wad falling in the wake of the one discharged by the rebounding air. It is also found that in this method very wet sand has to be used, otherwise sand is distributed throughout the entire foundry.

Underlying Principles.

The Beardsley-Piper sand-throwing machine has been developed with a view to producing moulds meeting the exact conditions of hand ramming, with various advantages as to the moulded condition of the sand, and also with particular reference to the speed of production.

From a moulder's earliest days he is taught to make a good facing on his pattern, if there are any complicated parts about, by throwing sand into these complicated corners. Passing through a jobbing foundry, it will often be found that a moulder, starting to ram, say, a toothed wheel, picks up handfuls of sand, which he slightly compresses and discharges with all the force he possibly can imply to it against the pattern. He knows full well that this method will put the sand into closer contact with the face of the pattern and give him a more exact finish on his mould than any other system of ramming. This principle is adopted on the Beardsley-Piper sand-throwing machine, with the difference that this machine throws about 1,500 wads of sand per minute, and keeps on throwing this until the mould is completed.

The essential principle of the Beardsley-Piper sand-throwing machine is to collect a wad of sand approximately the size of a large handful, compress this, and discharge it at a high velocity in a vertical line into the moulding flask. The head of the machine is so attached that it can be readily swung to any position desired within a full radius.

The machine consists of a ramming unit, and the existing moulding conditions in any foundry can be maintained. The impact of the sand is totally clear of any air discharged, as owing to the nature of the centrifugal paddle, which is constructed with one blade only, there is a minimum of fan action, and the only air that is disturbed is the amount of atmosphere which gets into the way of the sand when actually on the paddle, and in its course between the paddle and the moulding box. Careful examination has shown that this wad of sand, which starts in a triangular shape, rotates slowly in transit, and it is found one can ram with almost uniform efficiency at about 2 in. from the nose of the machine to about 10 ft. The slowing effect of the atmosphere on the sand reduces the efficiency, but it is very rarely necessary to throw sand more than 3 ft. to 4 ft.

The chief difficulty in other methods of moulding by throwing the sand was the lack of control as to the hardness or softness of the mould to be produced; but the method of application, chiefly due to the wad formation of the sand discharged, has provided for the variation necessary to meet the different conditions pertaining in a variety of foundries.

Working Details.

Fig. 1 shows a tractor-type machine in profile. It will be seen that the machine is travelling on the floor; it requires no foundation other than the level floor, but the makers have decided that it is advantageous to prepare a toothed track and fit a ratchet wheel to the machine so that one can definitely calculate the speed at which the machine will travel into the sand pile.

Behind this sand-throwing machine a pile of sand running the length of the shop, 9 ft. wide and about 2 ft. deep, is stacked in the route along which the machine will travel. A right- and left-handed screw operating at the foot of the machine

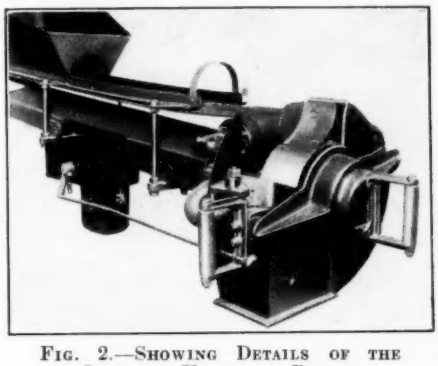

FIG. 2.—SHOWING DETAILS OF THE IMPELLER HEAD AND BLADE.

cuts a thin section of sand from this sand pile, and turns it over many times before bringing it to the elevator at the centre. This action has a very helpful effect in cutting the sand, and the action is sufficient to allow of the average foundry floor sand being piled up without any preparation other than the addition of the sprinkling of new sand on the surface, and a little moisture which need not be worked through the sand. With the sand-throwing machine a drier moulding sand is permissible than with ordinary hand-ram methods.

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* Abstract of Lecture delivered to the London and Scottish Branches of the Institute of British Foundrymen.

When the sand has been elevated to the top of the machine it is discharged into a reciprocating riddle with a big mesh, which clears from the sand any extraneous matter such as hangers, core irons, etc. When the sand has been riddled it is discharged in a constant speed on to an endless belt, and this belt travels through to an adjacent position on the tip of the machine.

Fig. 2 shows a section of the impeller head and the blade; it also shows the discharge end of the endless belt. Attention is drawn to the operation at this point. The speed of the impeller head is calculated in relation to the travel of the speed of the belt, so that with a 4-in. blade on the im-

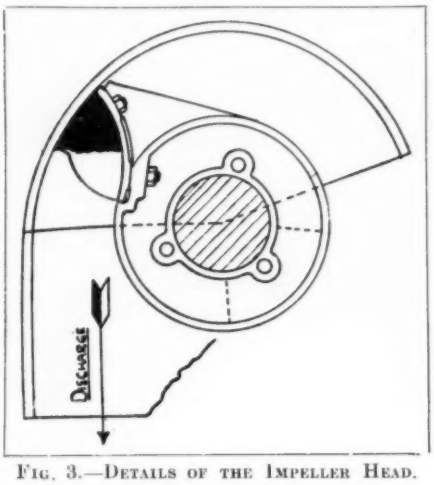


FIG. 3.—DETAILS OF THE IMPELLER HEAD.

peller head the belt will travel a distance of 4 in. during one complete revolution of the head. The sand leaving the belt continues to travel in a solid mass, and this is severed by a cutting edge on the inside face of the blade. This blade is arranged on a slight angle, which has been carefully calculated to prevent the sand which is following up on the belt from being interfered with in the way of splash. The net result is that a mass of sand is cut off instead of collecting falling sand. The centrifugal speed of the paddle immediately throws this sand to the outer edge of the blade, where it is held in position by the liner surrounding the head and forms into a triangular wad as on Fig. 3.

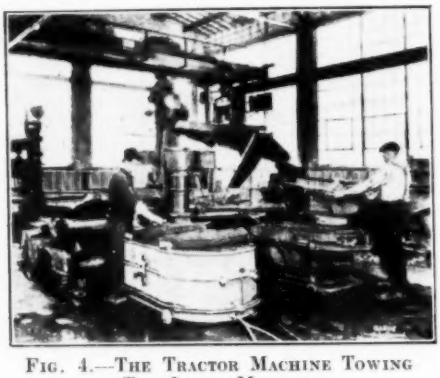


FIG. 4.—THE TRACTOR MACHINE TOWING TWO LARGE MOULDS.

By a slight adjustment of the paddle in relation to the outer liner a variation can be obtained in the density of ramming, which accommodates a mould sufficiently soft to make delicate aluminium castings, up to a hardness equal to withstand heavy steel castings. In Fig. 3 it will readily be seen how this can be obtained. If the tip of the blade is removed, say, ¼ in. from the liner, a thin spread of sand about ½ in. thick is left in the wake of the paddle, and this sand falls loose, while the wad is diminished in sand by the amount left; whereas when the paddle tip is brought closer to the liner and a minimum of sand is allowed to be spread, the wad will contain the bulk of the sand, and this being discharged in wad form produces the hardness desired. This application to the foundry is one of the most valuable functions of the machine.

Again referring to the wad-formation; this is very interestingly tested by holding a shovel directly in the discharge from the paddle head. The action is such that the shovel blade is thrust out of the stream by the distinct and definite rapping of the wads striking the blade. These wads are not only clearly felt by the person holding the shovel, but the sound of their striking is immediately audible to other parties present.

During normal ramming the head of the sand-throwing machine is kept moving constantly along the length of the box and pattern, so that each wad of sand deposited falls clear of the wad previously deposited. This allows of the sand to pack and set before the next wad is directly deposited on top of it. When it is taken into account that wads are deposited at the rate of about 1,500 per minute, it is easily appreciated that the mould is very quickly full. The standard machines are arranged to ram up to 10 cub. ft. of sand per min., and from this data it is easy to calculate production from the machine from known sizes of moulding boxes. A variation in the rate of travel of the head gives us a variation in the density of the mould, and there is in this respect a very simple method of producing soft places at command.

FIG. 5.—SHOWING A DAY'S OUTPUT WORKING ON PETROL CYLINDER CASTINGS.

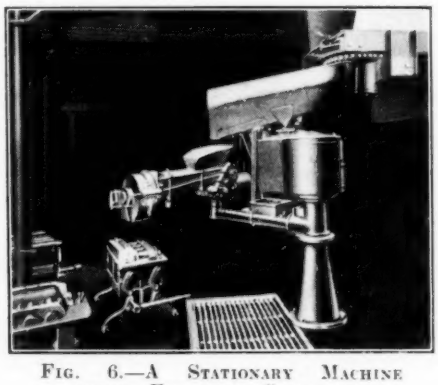


FIG. 6.—A STATIONARY MACHINE BEING FED WITH SAND FROM A REVOLVING DRUM.

If it is desired to make a soft spot, say, on the inside fillet of a casting, where contraction must be provided for, the wads are permitted to build up in a cone by holding the head stationary. The sand so piled has no binding effect on itself, and the result is a softer spot in the mould than the surrounding ramming.

When a mould has been completed, the machine can so finish the top that it requires no further ramming whatever, and the pattern is ready to draw immediately; also, that this machine is particularly suited to the use of stripping plates, as there is no jarring to disturb the operation of these rather delicate moulding machines.

The tractor machine is made in a variety of widths to suit the foundry conditions. The standard machine has a width of 9 ft., but machines of 11 ft. and 13 ft. span are in operation. With a 9-ft. machine the sand pile has a width of approximately 9 ft. and a depth of 2 ft., but where extra sand is called for a wider machine can be provided, and sand piles of 13 ft. × 4 ft. are in operation where a very large quantity of sand is desired.

The standard machine, both stationary and tractor, is fitted with a head having a radius of 9 ft., so that ramming can be undertaken at any point within this radius.

Transport Considerations.

Fig. 4 illustrates a standard tractor machine towing behind it two platforms on which are mounted large moulds. The machine slowly tows the moulds with it into the sand pile, and the speed of travel is sufficient to carry the machine clear of the pouring floor necessary for the moulds it has produced.

To the practical foundryman this must appeal very much, as anyone acquainted with mechanical moulding must have fully realised that the most important factor in getting production is one of transport. The Beardsley-Piper sand slinger makes transport a very much reduced factor by the very method of its operation.

The moulding machine travels into the sand pile, finds its own sand, cuts, prepares and mixes this, elevates it to a riddle where it is thoroughly mixed and screened, and any scrap, gaggers, wood or cores are collected and taken care of in a shoot

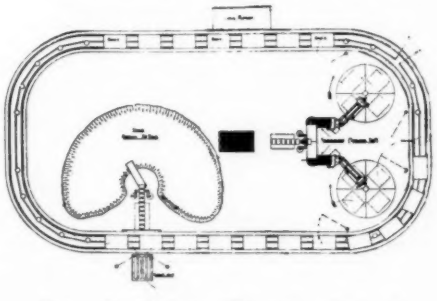


FIG. 7.—ROTARY LAYOUT FOR AN INDIAN FOUNDRY.

on the arm of the machine. The riddled sand, which at this point is in a silky condition, is transmitted to the belt and thence direct into the mould. The moulding boxes are laid right alongside the sand pile, the completed moulds are left in the wake of the machine, and the procession travels right along the shop, the moulds are poured and the sand and castings shaken out where they have been cast. The castings are removed, the moulding boxes laid at the side of the pile, the sand pile is collected into a heap, a sprinkling of sand is added to make up for the sand taken away by the castings, the pile is watered, and the procession continues in repetition throughout the day. The limit in repeating this process is controlled by the temperature of the sand.

When the sand slinger has completed its journey to the far end of the shop, it can either be reversed to work back, say, the following day, or it can be readily lifted and placed on another track to continue operating.

The total weight of the machine is approximately 3½ tons. The mobility of the machine was shown by a slide illustrating the tractor machine slung from an overhead crane.

Fig. 5 shows a typical installation of a tractor-type machine. This plant has been arranged for the manufacture of 6-cylinder petrol engine castings. The machine is shown in the distance. An interesting feature of this picture relates to the gantry across the shop. A long gantry is coupled on to the sand-throwing machine and is towed by same so that it is constantly in a relative position to the moulding machines towed behind the sand slinger. On this gantry are placed two small under-slung cranes fitted with compressed-air hoists. The moulding boxes are sufficiently light to be lifted to the stripping-plate machines by hand, and after ramming and stripping, the mould is lifted on the air hoist, travelled to the side, and the drag turned over and laid down, cores are added and the top part is next taken across and placed on top. It is presumed that a few drags will be made in advance of any top parts, so as to keep up the rotation and allow of the cores being placed. This installation is typical of a number of lay-outs presently getting wonderful results on production at the minimum of cost.

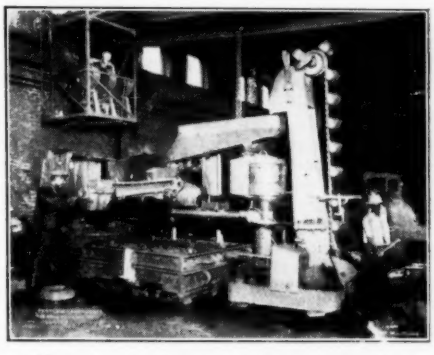


FIG. 8.—A PORTABLE SAND SLINGER BEING USED IN A JOBBING FOUNDRY. IT IS FED BY HAND-FILLING CONVEYOR BUCKETS.

The stationary-type machine, as shown on Fig. 6, is in the main a duplicate of the tractor machine, except for the pedestal which is extended and specially arranged for bolting down to the floor. With an installation of this kind, sand requires to be conveyed to the overhead hopper from a belt conveyor, or from a small bucket conveyor on the floor. One shop which the speaker visited in Chicago had two batteries of 8 machines, each fed from an overhead sand-conveying system. These 16 machines were in full operation, and a constant stream of sand was applied to their functioning. Such an installation, of course, is only applicable to a very large plant, as the output of castings from this foundry was enormous. The foundry in question was on the fourth floor of a building and the cupolas were on the same floor. The floor below was entirely given over to the rough cleaning of castings and to the treatment of sand. On the foundry floor there were large gratings through which the sand was dumped to be dealt with by

FIG. 9.—AT WORK ON A LOCOMOTIVE SIDE FRAME CASTING.

mechanical means on the floor below. On the second floor of this building the castings were finished, grouped and prepared for dispatch to other departments of the work.

Fig. 6 shows a stationary-type machine fed with sand from a revolving drum; it also shows a grating in front of the machine through which the sand is discharged when the mould has been filled. This has been done to save stopping and starting the impeller, as the work to be done was almost continuous. The stripping-plate machines mounted with motor cylinder blocks are carried by a turn-

table. On the present installation four such machines are mounted; turntables with six or eight machines are in operation. The turntable is geared so as to give a fixed speed of travel, and the operator of the sand-throwing machine stands in a central position working the head back and forward over the slowly-moving moulding machine until it is full, when he steps across to the next machine, which by this time has come into the radius of the sand-slinger arm.

On the installation shown on the picture 1,400 drag-part or top-part moulds of a popularly known four-cylinder engine are produced per 8-hour-day. Two of these installations are mounted in close proximity, the drags being made and reversed, placed on to a moving conveyor which passes a cross conveyor carrying cores. Twenty-two cores are placed in position and the mould is allowed to travel forward to the next installation of the sand slinger, where the top part is placed in position, clamped, and again passed forward to be poured. The poured mould travels forward to a mechanical shake-out, the boxes are returned to machine, the casting proceeds to the dressing shop, and the sand falls down through the shake-out to a preparing room, where it is fed overhead back to the sand-throwing machine. Repeats of this installation are presently in hand for the same company.

Fig. 7 is an outline-plan arrangement of a rotary moulding scheme laid out for the manufacture of bowl sleepers in India. The first moulding machine is making drag parts, the moulding box is collected from the conveyor and replaced on the conveyor when it has turned the corner. Cores are placed in between this point and the position round the next corner; there, the top part is placed in position, the completed mould travelling forward to the pouring station. Sufficient travel is permitted to allow of the castings cooling when they reach the mechanical shake-out. The mould is placed on this, the sand falls directly through into a centrifugal aerator, which breaks up the sand and helps very much to cool it. The aerated sand is accumulated in the boot of an elevator which raises it to a height of 16 to 18 ft., and discharges on to a shoot which spreads the sand over a large area. The sand in this heap is watered from a fine spray and is fed by grab bucket into the grating behind the elevator to the sand-throwing machine.

Each mould requires about half a minute for its production, viz., half a minute for the drag on No. 1 machine and the same time for the cope on No. 2 machine. The production obtainable from this installation will obviously be high.

Fig. 8 shows portable-type sand-throwing machine specially designed for use in jobbing foundries. The illustration clearly shows the ramming up of a large square box by the sand, which in the ordinary jobbing method would be shovelled into the mould to be rammed by hand. This particular installation has proved so successful that very little hand ramming is now permitted. In the case of large moulds the machine is carried alongside of the moulding box, and in some cases has to be moved two or three times, while in the case of small moulds made from ordinary split patterns these are carried to the moulding machine, as this proves more convenient; this, of course, will emphasise the importance of transport, with a view to getting production.

Jobbing Work.

Sand joints can be produced quite as satisfactorily as by hand-ramming methods, a coating of parting sand being all that is necessary. It is not claimed that under-ramming can be effected by the machine to less than 45 degs. angle, but in Scotland it has been demonstrated in a most surprising way the ability of the machine to under-ram fillets of considerable length and sharpness. The action of the wad falling on to the previous body of sand has a ramming and spreading action very similar to that obtained by a moulder when he is spreading his sand in against the surface of the pattern. The wad striking on the sand rams the surface of the existing sand and spreads itself over that surface, packing very tightly up against the surface of the pattern.

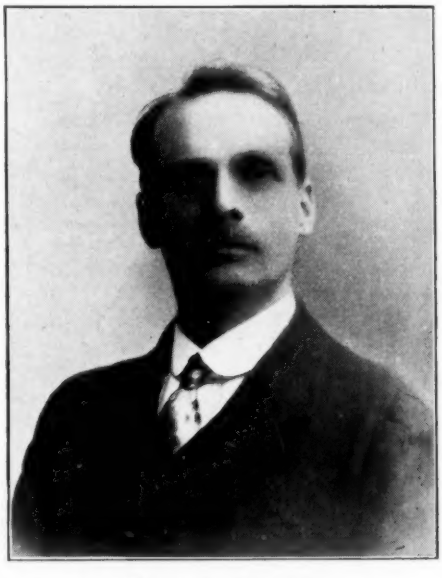
Two men working diligently with shovels can keep the machine going at about 9 cub. ft. of sand per minute, and when it is realised that the men have a fixed point into which to shovel, it will be gathered that the saving of time, as compared with shovelling the sand loosely into a moulding box to be later rammed by a moulder as in existing jobbing practice.

Fig. 9 shows the portable machine applied to a very long casting of a locomotive side frame. The machine is shown suspended on the crane, being lifted out of the way to allow of the finishing of the mould.

Machines have been built on trucks carrying eight or ten tons of sand, and these can be readily moved up and down a moulding shop to make moulds on a production basis. This type of machine which is expected to be demonstrated in Britain at an early date has a considerable future before it.

"Moulders" of the Industry.—No. 10.

Mr. Bartlett springs from a real foundry family, being the third generation to practise the art. Evidently it was the art side of foundry work that his family appreciated, as he was apprenticed to Messrs. H. Young & Company, of Pimlico, who carry out statuary and art founding in general. After serving his time, he changed over to heavy engineering foundry work. This was in 1893, when



MR. A. R. BARTLETT.

he joined the firm of Messrs. Fraser & Chalmers, Limited, of Erith, now a branch of the General Electric Company. After 30 years' service with this firm, he is now one of their oldest and most respected members of their staff.

Mr. Bartlett was one of the founders of the London Branch of the Institute of British Foundrymen, and has filled the Branch-Presidential chair. He is now a member of general council, and serves on the Finance Committee. He has read Papers on practical subjects before practically every branch of the Institute, his Paper on "Safety First in the Foundry" being a standard reference on the subject. This and "Foundry Apprenticeship" are his two pet subjects, and he showed his practical interest in the latter by acting as honorary secretary to the London and South of England Committee appointed to consider and report on the question.

THE PNEULEC MACHINE COMPANY, LIMITED, of Smethwick, Birmingham, manufacturers of foundry equipment, have appointed the Blackfriars Foundry Equipment Company, Limited, their agents for London and the South of England.

An Apprenticeship Course in Foundry Practice.—LI.

By Ben Shaw and James Edgar.

METAL PATTERN-MAKING.

The use of metal for patterns has increased during recent years, especially for patterns the castings from which are of a repetition character, such as motor-car engines. The different metals and alloys used in making the patterns vary with the class of work required, with the methods in vogue in different shops, and are sometimes governed by the material of which the final castings are required to be. Patterns are made of iron, brass, white metal, aluminium and lead, and tin-zinc alloys are commonly used for certain work.

In some foundries no special pattern metal is used, but patterns are cast from whatever metal is being used. This is especially true of shops where metal patterns are only used in exceptional cases. A few castings may be required, and it may be advisable to make an iron pattern from a flimsy wood pattern supplied by the pattern shop. When a few castings are required of small or medium size, and great accuracy is not essential, boards may be provided with which one casting will be made in loam or green-sand, and the first casting can be used as a pattern for subsequent castings. This method is obviously limited by various considerations, apart from the question of accuracy. It is useless for intricate cored work, and there is also difficulty when there are machined faces, unless double machining is allowed on the first casting. When making coarse work on which a fine skin is not essential—such as firebars—a rough metal pattern may serve the purpose.

It is not strictly true to state, as is sometimes done, that metal patternmaking enables more intricate work to be executed, because there is no conceivable design that cannot be made in wood. There is the difference, however, that whereas it might be necessary to make a block pattern and core-boxes if wood were used, it may be possible to make a shell pattern in metal. Thus, whatever additional cost is involved in the patternmaking is saved ultimately in the foundry. Another point is that the shell method may be the only practical one for a very delicate casting, and wood is not as durable as metal when several castings are required. It must not be supposed, therefore, that metal patternmaking is only suitable for repetition work; it may be advisable to make a pattern in metal when but three or four castings are required. The method should always be regarded as a practical alternative when there are difficulties in making a wood pattern.

Tapering and Machining Allowances.

Metal does not warp, nor are its dimensions affected by dampness. A metal pattern, with reasonable care, will stand thousands of castings being made from it and be as good at the finish. It may be said, indeed, that when they are scrapped it is invariably because they have outlived their design. When they are properly made they withdraw cleanly from their moulds, and in consequence involve less making up by the moulder. When they are badly made, however, as they are unyielding, a great deal of labour may be involved in finishing the mould. It is absolutely essential, therefore, if metal patternmaking is to prove economical, that the workmanship should be of the best. Unlike wood patternmaking—unless in such special cases as have been already touched upon—there is only one class of pattern. The apprentice should always remember when making metal patterns that too great care cannot be taken in tapering vertical sides, in leaving just the necessary machining, and in fitting all loose pieces so that there is no shake. If properly made, metal patterns ought to reduce subsequent machining costs, because it is possible, with a material that does not alter in shape, to reduce machining considerably. It is common in many shops to allow $\frac{1}{8}$ in. on faces for machining on hand-moulded cast-iron work, but with metal patterns this can well be reduced to $\frac{1}{16}$ in. Time is also saved in marking off castings from metal patterns because of their greater accuracy in dimensions and thickness.

Constructing Metal Patterns.

It may be possible to sweep the pattern up, or a master wood pattern may have to be made. With fairly large cylinder or valve covers, or work of a like design, it is usually possible to sweep them up in loam or green-sand. With designs of a square or irregular section a very flimsy or skeleton pattern may answer. It is often much quicker, however, to make a proper pattern. For example, in the case of dome-shaped covers, the customary method of making a wood pattern is to build it segmentally and turn it inside and outside afterwards. If for a metal pattern, however, such a cover can frequently be satisfactorily turned from solid dry timber. The several thicknesses would be glued back to back, and it would not be necessary to either paint or varnish the pattern, because it would be a one-off job. The drawing might give the metal thickness, but this would be increased to give sufficient allowance for a skimming cut being taken from the metal pattern. In all but the simplest work it is necessary to set down a pattern on a drawing board. The best procedure for comparatively small work is to set down the work from the drawing and then redraw alongside to double contraction size, but this takes much time. A careful drawing should be made, however, showing single and double machining. If a quantity of castings is required, special jigs may be made for machining them, hence more machining may be necessary for the metal pattern than for the final castings. The important question of contraction depends on the metal of which the pattern is being made and also the metal for the final casting. When iron patterns are being made for iron castings, the double contraction rule serves the purpose, but if aluminium patterns are being made for iron castings, a special contraction has to be calculated. It is advisable when different metals are being used for the patterns from that of the final castings, to make a special rule. Some men calculate a percentage on dimensions, but it is an extremely slow method, and likely to lead to serious errors. It is better to find the length on a contraction rule, representing one of the metals, with a standard rule, and use the dimension so obtained with a contraction rule representing the other metal. Thus, suppose the pattern is to be brass and the final casting cast iron, and we take a dimension required to be 8 in., the 8 in. on the contraction rule for brass would measure $8\frac{1}{8}$ in. with a standard rule, and if this $8\frac{1}{8}$ in. be determined with the contraction rule for iron, the final measurement will give the double contraction allowance necessary. With regard to machining allowances, it may be taken as axiomatic that no part of a metal pattern should be left rough. Therefore, turning and planing allowances should be left on circular and flat faces, although elsewhere the rapping when moulding will generally give sufficient metal for filling and scraping.

Wood and Metal Patterns.

There are several reasons why it is advisable simply to make the main body of a pattern in metal and add the details in wood. One important consideration is that it allows of better finishing. A circular pattern may be turned, for instance, and ribs and bosses fitted on subsequently, the completed work being of the utmost smoothness and accuracy, whereas it would be exceedingly difficult to scrape the casting smooth if ribs and bosses were cast on. In most cases also it is cheaper to machine the work and fit wood parts than to scrape it. There is another consideration which is of equal importance, and that is that wood details facilitate alterations. It is for this reason that even flanges are frequently made of wood. Sometimes one metal pattern will suffice for several

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different designs by simple alterations made to ribs or flanges. It is usual, therefore, in nearly all cases that are likely to be subject to modifications not to cast small parts on the main body. There may be a difficulty in making the fillets, of course, and half the gain of metal patterns is lost if the moulder has to cut the fillets himself. The best fillet for metal is one made of beeswax, which is easily worked and it holds. Prints should never be cast. Even with circular covers the prints should be made separately. With circular prints, accurate setting is easy with the aid of dowels. Holes can be drilled in the casting and the prints turned with dowels to fit them. It is not necessary that such prints should be fastened with screws; indeed, it is a distinct advantage often for the prints to be loose, as the moulder can use them when finishing his mould and replace them on the pattern when he has finished.

Valve Seals.

The young patternmaker should also always remember the use he can make of metal for making delicate parts for a wood pattern, as, for example, valve seats. In many valves the seat must be loose, and, as it may be a dovetailed ring not more than $\frac{1}{4}$ in. or $\frac{3}{8}$ in. thick, even hardwood is unsatisfactory. Some craftsmen make use of plywood for this purpose, but it is not as satisfactory as metal. Sometimes a lead alloy is used for the purpose, often brass, and occasionally iron. For small parts such as this, machining is not usually essential, as the finishing can be done very accurately with a file. As a general rule it is inadvisable to make small parts of a wood pattern in metal unless they are very delicate.

Dowels for Metal Patterns.

Metal patternmaking in many shops is regarded as a distinct trade, although why this is so it is difficult to understand. Practically the same knowledge is necessary as for wood patternmaking. Marking off a metal pattern is very like marking off a casting, except that bolt holes are ignored. Every part should be machined if possible, and parts which cannot be machined should be filed and scraped until all irregularities are removed. The metal patternmaker makes special scrapers for use in corners where it is impossible to use a file. When fitting loose parts, the dowels are soldered or screwed into the parts, and these dowels should be short—much shorter than for wood patterns. Better than dowels, however, are socket joints or dovetails. Dovetails are admirable, but they are difficult to fit accurately. When mounting metal patterns on a plate, there are three methods available—riveting, screwing or soldering. Soldering is not satisfactory because at any time it may be necessary to take the pattern off the plate. If the patterns are fastened temporarily with shellac, holes may be drilled through pattern and plate and copper rivets inserted. This is a very satisfactory method, although subsequent adjustment of the work is impossible. The best method is screwing, but it involves most work. Slight adjustment is possible when screws are used, and the patterns can be quickly removed if necessary.

For some work a metal pattern is required, and yet it may not be practicable to make a shell pattern. The apprentice is often at a loss as to what thickness of metal should be allowed, and it is quite impossible to give a definite answer. For small work, $\frac{1}{4}$ in. or $\frac{3}{8}$ in. may be sufficient, while for large work it may be necessary to make it 1 in. It is not satisfactory to consule the drawing and make it approximately the casting thickness, because the conditions of service are altogether different. For medium-sized work, probably $\frac{1}{2}$ in. or $\frac{5}{8}$ in. is sufficiently thick. The same care is not necessary with the inside of a block pattern, of course, and the contour of the outside need not be followed. Thus, at one part the metal thickness may be $\frac{1}{2}$ in. while at another part it may be $\frac{3}{4}$ in. or more. It is sometimes advisable, with irregular-shaped work, to strengthen the pattern with one or two ribs fitted on the inside.

Cast iron is the most generally used metal for pattern-making. It has the advantage and the quality of keeping its shape; it is not only stiff, enabling it to resist bending, but it is hard enough to resist knocks without being bruised. The iron most suitable is a close-grained grey iron, such as is frequently used for light machinery castings.

Preserving Iron Patterns.

A disadvantage in the use of iron is its tendency to rust when it comes into contact with the damp sand. To counteract this tendency, and, indeed, make a pattern practically rust-proof, is to coat it with beeswax. To apply the wax successfully, it is necessary to have a smooth surface. Patterns should first be heated and then coated with a solution of sal-ammoniac and water; after they must stand until the whole surface is thoroughly rusted. It takes several hours for the rust to penetrate deep enough. A vigorous rubbing with a wire brush will remove the rust, and a good polish can be given to the metal with a piece of coke. This provides an ideal surface for the wax, which should be applied warm, with a soft brush, the pattern having been previously heated. The surface can be polished when it has cooled. This surface will remain proof for a considerable time, but it is necessary to re-coat occasionally with wax. The use of beeswax is impossible, of course, if the pattern has to be heated which is the alternative method of preventing the roughening of the surface of the mould caused by the damp sand in contact with the cold exposed surface of the metal. In British foundries, the method of coating the pattern is more generally adopted than heating, which may be done by gas, oil, or it may be heated electrically. Moulding machines are sometimes equipped with heaters. For very small light work, cast iron is not a suitable metal, because it is either difficult to form or to maintain where there are complicated outlines.

Metals Used.

It is quite common for an order to be received by a foundry for a large number of castings, only one pattern being provided. It is usual then to use the pattern supplied as a master pattern, from which a number of other patterns are made. These patterns cannot be turned, but they should be scraped as smooth as possible. One of the white metals may be used for such work, and a useful alloy is composed of tin and zinc. This alloy, in the proportion of equal parts of each, contracts about 1-64th per ft.; therefore, with small patterns, there will be no appreciable difference between the original pattern supplied and those made from it, as the slight increase, due to rapping, will compensate for the slight loss in shrinkage. Sometimes a non-shrinking alloy is used, consisting of 85 parts lead, 10 parts antimony, and 5 parts tin. The objection to both these alloys is their comparative softness, which makes them easily dented and distorted. A stiffer and harder alloy consists of 85 per cent. tin and 15 per cent. antimony. The objection against this alloy is its cost, and this usually weighs against it when a foundry is making patterns at its own cost, which ought, strictly speaking, to have been supplied by the customer. A great recommendation of the tin-zinc alloy is the ease with which patterns can be finished and parts soldered together. Here it may be stated that, when making metal patterns, it is sometimes much easier to make them in two or more parts and afterwards join them. It also simplifies machining, just as with ribs and bosses. Another recommendation of such an alloy is the speed at which the patterns can be made, because of its low melting point. This is important, because a foundry may get a large number from one pattern with a time limit for delivery.

In brass foundries, the tin-zinc alloys are used largely for temporary patterns, because of no other consideration than that they can be melted down and used in making alloys of which tin and zinc form a part. The mixtures usually vary to suit the mixtures of metal for which they are likely to be used afterwards.

Neither brass nor gunmetal are very commonly used for patterns; such that are made usually consist of the mixture being used in the foundry for general work, but aluminium has become popular. It is light, easily finished, strong, and it can be cast into intricate shapes with little difficulty. It is not free from disadvantages, however. It has high and inconsistent shrinkage, it is very hard to solder, and even when two parts are soldered together, they may come apart if used on a jar-ramming machine. Yet, on the whole, it is a serviceable metal, and is much used for patterns for fine work, such as castings for internal-combustion engines.

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Cast iron is the only metal that requires to be coated, as neither brass nor the white metals rust, nor do they corrode to any appreciable extent. In most foundries that only make metal patterns occasionally, it may be admitted that the metal is not chosen because it is the best for the purpose. In an iron foundry, iron will be used if it is practically possible without regard to whether it is best for the purpose, and in a brass foundry, the same applies; any mixture may be used that is being poured at the time the moulds are ready. It is very necessary, even when no machining is done to a pattern, that it should be carefully checked before being passed for use. Metal patterns are not a recent innovation, but their use is certain to be greatly extended in the future, and apprentice foundrymen would do well to devote attention to the subject.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Cast-Iron Test Bars.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I notice in Vol. 27, No. 354, a tentative specification for grey-iron castings, and, as I am very much interested, I wish to make the following comments:—

(1) "Test bars are to be cast two in a box," but no statement is made as to whether horizontal or cast on end. This is important.

(2) The option of transverse testing "as cast" or skin-machined suggests considerable variation, and is quite a departure for transverse testing.

(3) If cast horizontally, a limit should be fixed for the height of runner box, otherwise the bars may be cast under an excess pressure and give a questionable result.

(4) The bars, when removed from the mould, are not to be dressed by putting through a rumbling barrel, subjected to severe hammering, or any other treatment which is liable to settle the molecules by vibration.

(5) *Chemical Analysis.*—The Inspector should be able, on demand, to see the analysis records of any material used in his castings, and be able to accept the figures submitted as far as he thinks fit. This is necessary, I think, as in No. 8 Inspection he shall "reject any casting or material that is unsound, etc.," and this is not always visual.

At present I am inspecting castings where transverse test is specified, and also Si, P, Mn and c.c. content.

(6) Where test bars represent continuous melting on a repetition job, bars should be cast at regular intervals of not less than one hour's duration.

(7) As iron is so difficult to melt under constant conditions giving an unvariable result, I think it should be stated that the specification generally should be without a really *definite fixed* figure, so that to a certain extent an Inspector may use his own discretion where failures of tests involving rejection are concerned.—Yours, etc.,

H. LEWIN, A.M.I.B.F.

Kulti, E.I. Railway, India.
June 26, 1923.

Cleaning Castings.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I note your editorial on "Cleaning Castings," by which I presume you wish to emphasise the importance of the trade considering the proposed Regulations before they are actually put into force.

I must say I do not agree with your comments, for the reason that several of the Regulations are useless, and are an unnecessary addition to the cost of production; secondly, too much power is given to inspectors, and a constant source of irritation will be provided as to how the innumerable odd jobs in the works shall be carried out, and putting the inspector into the position that, if he insists on the Regulations being strictly adhered to, the costs in some cases will be increased two and three times.

Also, in the general Regulations, I note it is necessary to water the fettling shop floor, with the result that castings will be spotted with rust, with a result that in several branches of the industry they will then be unsaleable.

Practical men can readily see that in many ways the proposed Regulations will increase costs both direct and indirect, with increased supervision expenses, increased local rates, etc., etc.

With trade in such a parlous state, and with iron at over 5s. 6d. per cwt., and castings being sold at 12s. 6d. per cwt. to the public authorities, and at the same time the makers are inferentially being accused of profiteering, one wonders at a Government Department proposing such Regulations, when at the same time other Government Departments are endeavouring to assist trade and urging the employers to find employment for the workers.

If these proposed Regulations are allowed to go through in their present form, there will be less work for the British workman, whilst a number of employers will be in a much better position than they are to-day by finding employment for workers abroad. In the interests of the country as a whole, I consider the position should not be allowed to be created.—Yours, etc.,

Keighley, July 17. WALTER SLINGSBY.

Vanadium in the Iron Foundry.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to your editorial comments appended to the article from my pen published in your issue of July 19, may I be allowed publicly to reply to them?

My endeavour in that article was faithfully to place on record a synopsis of the actual observations of many years, supplementing the same where feasible with typical numerical records. In regard to the linking up of porosity and liquid contraction you are most unquestionably right in saying that the foundry metallurgist would draw the inference you suggest. I would like to point out, however, that I stated that the "porosity referred to is not sufficiently gross to be distinguishable by the naked eye, or even at comparatively low liquid pressure," whence it would hardly be expected that the normality of the shrinkage would be visibly affected either.

But I am not at all clear that the ordinary phenomena of "liquid contraction" are *in this case* the responsible agents: in fact I have an uneasy feeling that any attempt at their correlation in this instance is somewhat akin to our trying to visualise "half a pound of a quarter past three." Must we not look to some other cause? Tentatively I suggest that it is to the phenomenon of surface tension, as existing between the particles of metal already set and that portion still liquid, that we must look. I do not necessarily suggest that any change in surface tension is brought about by direct solution of the vanadium so much as by the expulsion by it of a detrimental solute such as nitrogen or a nitride. That the correct vanadising of cast iron *does* eliminate this class of porosity is certain, *why* and *how* it does it must at present be a matter of conjecture.

I yield to no man in my respect for, and admiration of, theory: the logical development of theory is responsible for steady progress. But I respectfully submit that most theories have their inception in observation, and subsequent classification, of empirically obtained data.

Fully do I realise that by reason of the foregoing I lay myself open to the charge of being a dreamer. Still, the ideas of the average metallurgist of to-day would have been, but a short generation ago, attributed only to the most confirmed of "cranks."

Yours, etc.,

J. KENT SMITH.

ALDERMAN A. E. PRITCHARD, J.P., of Wednesbury, upon whom a knighthood has been conferred, is head of the firm of Thomas Pritchard, Limited, South Staffordshire Patent Tube Works, Wednesbury. He has been closely connected with municipal work in Wednesbury for 37 years, and is the sole survivor of the original Corporation. He has been six times Mayor of the Borough, and some eight or nine years ago the freedom of the Borough was also conferred upon him in recognition of his public work.

Some Experiments on the Malleablising of Cast Iron.

(*Continued from page* 61.)

The distribution of the temper carbon in test (*b*) is shown in Figs. 10, 11 and 12, and in test (*d*) in Figs. 13, 14 and 15. Test (*a*), being substantially the same as test (*b*), is not shown.

Test samples 4 and 3, containing little or much sulphur and little manganese, do not differ appreciably in test series (*a*) and (*b*) (900 deg. C.). No. 4 exhibit a narrow marginal zone practically

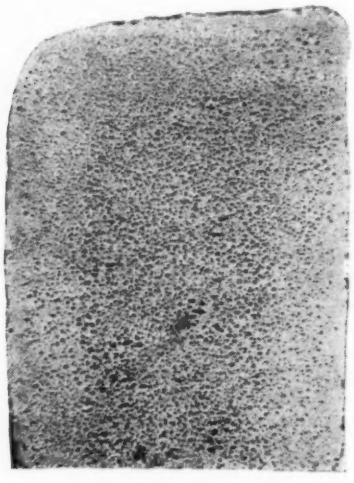


FIG. 10.—(×6 DIAS.).

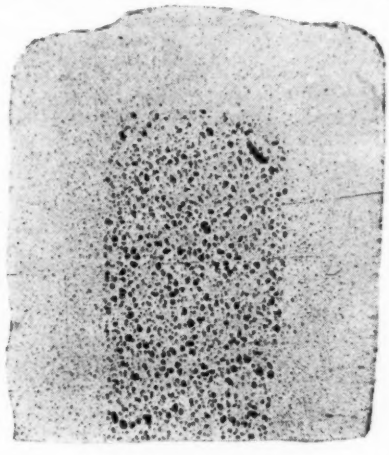


FIG. 13.—(×6 DIAS.).

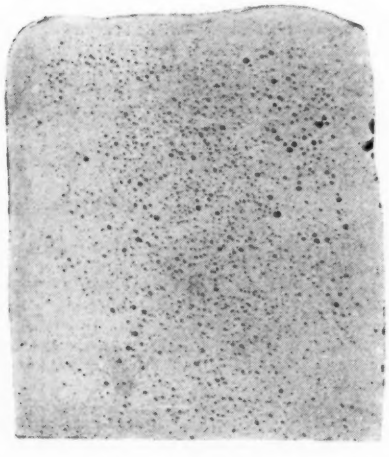


FIG. 11.—(×6 DIAS.).

FIG. 14.—(× 6 DIAS.).

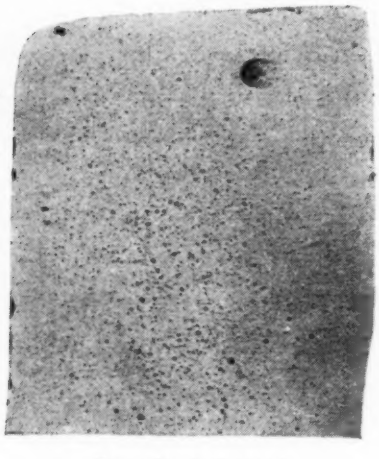


FIG. 12.—(×6 DIAS.).

FIG. 15.—(×6 DIAS.).

FIGS. 10 TO 15.—DISTRIBUTION OF TEMPER CARBON IN TEST (B) LEFT SIDE AND (D) RIGHT SIDE.

free from temper carbon, a transition zone with little and an inner zone with much temper carbon. The transitions between the different zones are gradual. With a higher sulphur content, as in samples (3), there are apparently only two zones—a narrow zone more or less well defined and containing little if any temper carbon, and an inner zone with a high percentage of temper carbon evenly distributed. Where there is much sulphur

FIG. 16.—CARBON-FREE OUTSIDE ZONE WITH A LARGE AMOUNT OF PEARLITE IN THE FORM OF LARGE ISLANDS. TRANSITION ZONE PRACTICALLY FREE FROM PEARLITE. BETWEEN THE LATTER ZONE AND THE OUTSIDE ZONE IS AN AREA CONSISTING OF AN ACCUMULATION OF PEARLITE. (× 6 DIAS.)

and manganese (*b*), the quantity of temper carbon is very small in the first two series of tests, while, just as in the case of the low-sulphur samples, the temper carbon seems to increase gradually from the edge to the centre. This is also true where malleablising was carried out at high temperature (test series *d*, sample 6, Fig. 15), although it is

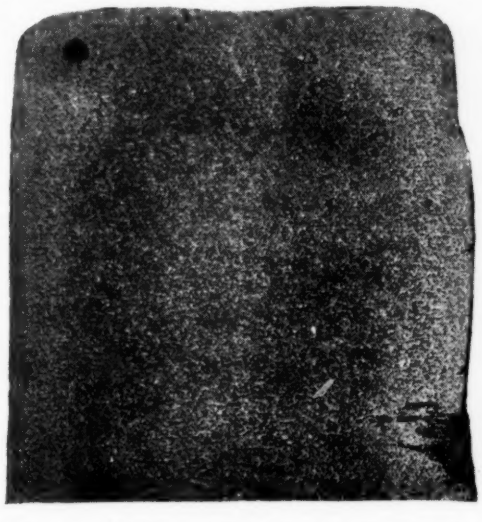


FIG. 17.—CONTINUOUS TRANSITION OF COMBINED CARBON CONTENT FROM OUTSIDE TO CENTRE. IN THE INTERMEDIATE ZONE THERE ARE OCCASIONALLY ACCUMULATIONS OF COARSE PEARLITE, AND IN THE MIDDLE OF THE CENTRAL ZONE, CEMENTITE. (× 6 DIAS.)

not so where manganese is absent (sample 3, Fig. 15). On the other hand, in this particular case, just as in test series (*a*) and (*b*) there is a marginal zone with but little temper carbon, and a central zone rich in temper carbon, both zones being well defined, and the area of the former zone being considerably the greater. As will be seen from Figs. 13 and 14, the final extent and arrangement of the zones is apparent even with 10 hours malleablising, the only difference being in the quantity of temper carbon present.

The sharp definition of the zones, especially in test series (*d*), is a result of the sulphur being distributed in the same way, and has nothing to do with rapid cooling, otherwise the low-manganese sample in which the remaining constituents are approximately the same, must have exhibited this

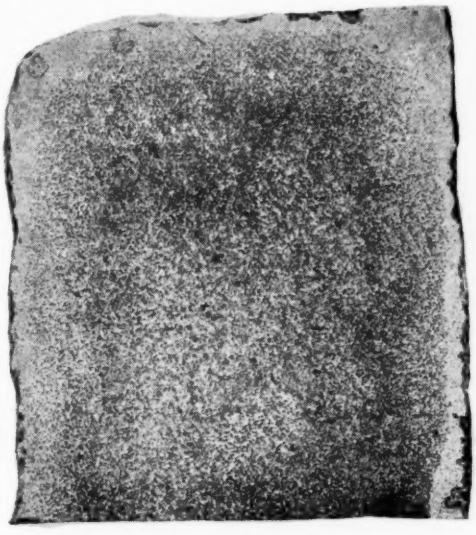


FIG. 18.—COMPLETELY DECARBURISED OUTSIDE ZONE WITH ABRUPT TRANSITION TO CENTRAL ZONE. IN THE LATTER ZONE, GRADUAL TRANSITION TO CENTRE. HERE FREE CEMENTITE AND PEARLITE.

sharp definition of zones. The better notch-impact strength of the low-manganese and high-sulphur casting may also be a result of the absence of sharply defined zones, both as regards the sulphur and the carbon.

The distribution of the combined carbon is

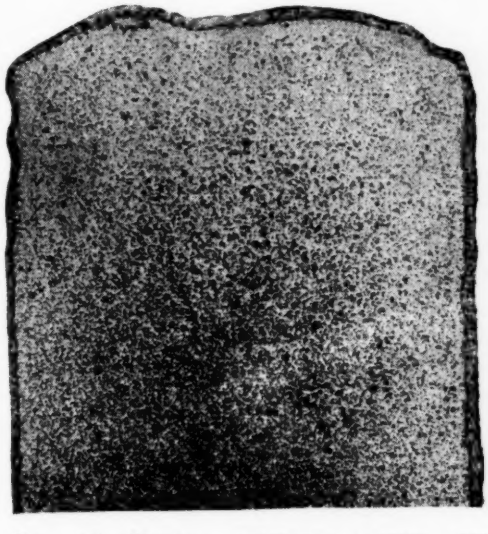


FIG. 19.—GRADUAL TRANSITION BEYOND THE EXTREMELY OXIDISED MARGINAL TO THE MIDDLE. (× 6 DIAS.)

shown in Figs. 16 to 21. Whereas test series (*a*) and (*b*) scarcely differ at all as regards the distribution of the sulphur and the temper carbon, this is not so with respect to the distribution of the combined carbon, although, as Fig. 4 shows, there is but little difference between the percentage of combined carbon in the two sets of samples. Sample 6 (*d*) is rather remarkable by the extremely uniform distribution of the combined carbon, and sample 3 (*d*) by the absence of a sharply pronounced connection between the distribution of the sulphur and the temper carbon and the distribution of the combined carbon.

XUM

The Oxidised outside layer or "skin."

It was found in the case of those samples which had been malleablised in pure hematite ore that oxidation on the outside was not appreciably greater than in the samples malleablised in mill scale. Slight oxidation had occurred in all samples quite apart from their sulphur and manganese contents. In the samples that had been malleablised at 900 deg. C. this oxidation was a

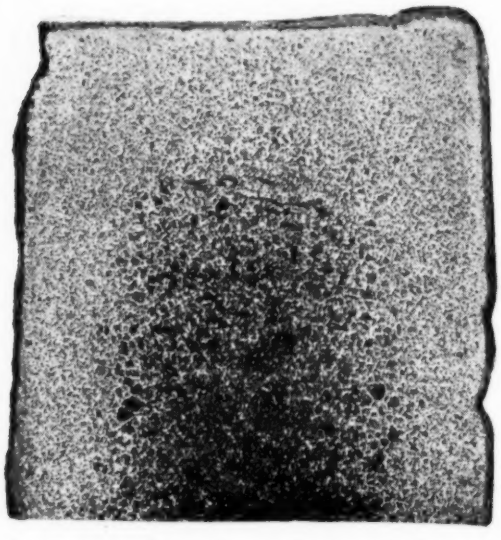


FIG. 20.—AS FIG. 19, BUT MORE MARKED SEPARATION OF OUTSIDE AND CENTRAL ZONE. (×6 DIAS.)

thin strip 0.1 to 0.3 mm. thick, in which the ferrite crystals were dotted with black oxide points as shown in Fig. 22.

In the samples malleablised at 1,030 deg. C., however, the skin is deeper (see also Figs. 19 to 21), and a further phenomenon is apparent in the presence of a coarse network of large oxide accumulations, which sometimes assumed a definite

FIG. 21.—WITH THE EXCEPTION OF A FAIRLY RESTRICTED INNER ZONE WITH COARSE PEARLITIC CRYSTALLISATION, THE PEARLITIC DISTRIBUTION IS FAIRLY UNIFORM OVER THE WHOLE CROSS-SECTION RIGHT UP TO THE EXTREMELY OXIDISED OUTER ZONE. (×6 DIAS.)

pattern and were sometimes quite irregular (Fig. 23). Under the microscope these enclosures appeared dark grey in colour, somewhat greyer than the manganese sulphide enclosures. They were quite homogeneous, and were not attacked by any of the reagents used. They are certainly oxidised in character.

Thus it is possible in malleable castings to differentiate two spatially separate phenomena of oxidation—one, the outer and coarser one, due to superoxidation as a result of an excessive malleablising temperature, or to too-high an oxygen content of the packing medium; and a fine reticular structure which the present experiments have shown to be peculiar to all malleable castings, and which is therefore of considerable significance.

The oxide skin was always perfectly free from

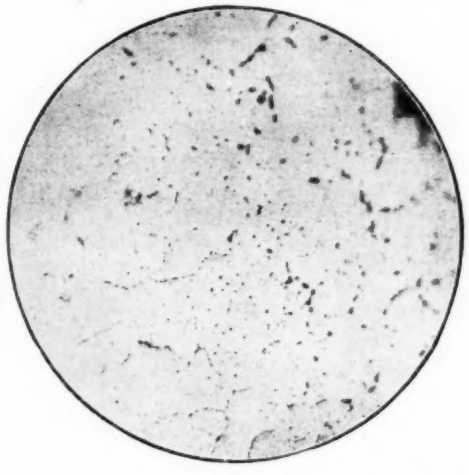


FIG. 22.—OUTSIDE LAYER (SKIN) OF SAMPLES MALLEABLISED AT 900 DEG. (×200 DIAS.)

the sulphide inclusions originally present in the iron, whether these inclusions are iron or manganese sulphide. Very occasionally there was considerable accumulation of sulphur between the fine reticular inner zone and the coarse-reticular outer zone, as may be seen in Fig. 24, which refers to a technical product. Other sulphur inclusions frequently occur, these having subsequently found their way into the oxide skin from the inside or outside. These secondary sulphur inclusions have

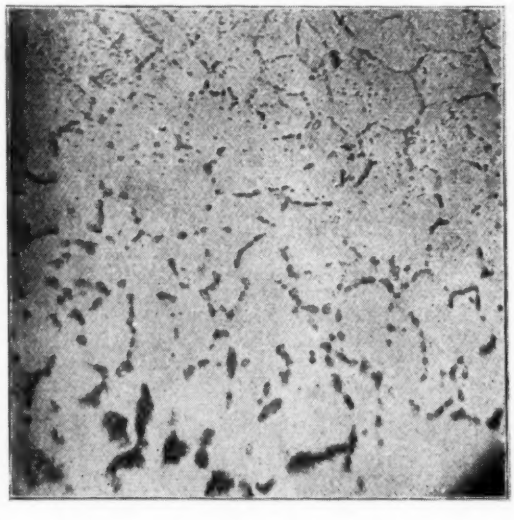


FIG. 23.—OUTSIDE LAYER (SKIN) OF SAMPLES MALLEABLISED AT 1,030 DEG. C. (×200).

the same yellowish-brown colour as the eutectic iron—iron sulphide (Fig. 25). Isolated instances have been found where iron disulphide enclosures have been present. Nothing definite, however, can be stated with regard to these inclusions; they are possibly due to interaction between ferrous oxide and ferrous sulphide.

To throw a little further light on the matter, the layer of "skin" was removed from four of the samples and analysed for carbon, sulphur and oxygen, the following being the results:—

Per Sample.	Per cent. C. in outside layer.	Per cent. C. in entire cross-section.	Per cent. S. in outside layer.	Per cent. S. in raw material.	Per cent. O. in outside layer	Per cent. O. in cross-section.
3b ..	—	—	—	—	0.142	0.042
3d ..	0.22	0.36	0.124	0.359	0.192	0.050
4d ..	0.16	0.38	0.06	0.014	0.240	0.047
6d ..	0.15	0.48	0.324	0.370	0.306	0.053

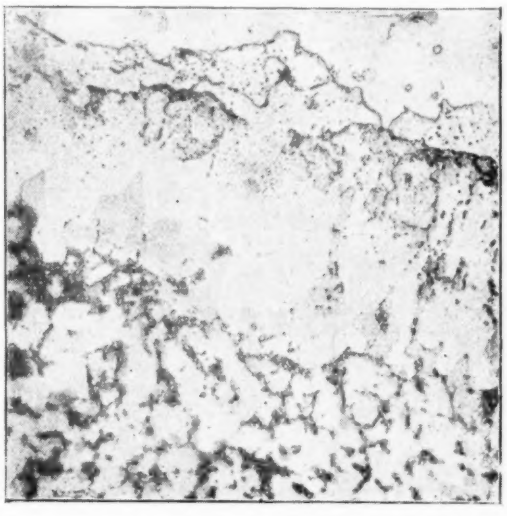


FIG. 24.—ACCUMULATION OF SULPHUR IN THE ZONES OF OXIDATION OF A TECHNICAL PRODUCT HAVING A THICK SKIN. (×200 DIAS.)

This proves the outside edge of the malleable casting to be enriched by oxides. Even when it is remembered that the marginal layer in annealed malleable castings generally consists of fully decarburised iron, the quantities of carbon are still high in this layer. The micro-examination, however, confirms the chemical analysis, for pearlite is found in all samples in the region of

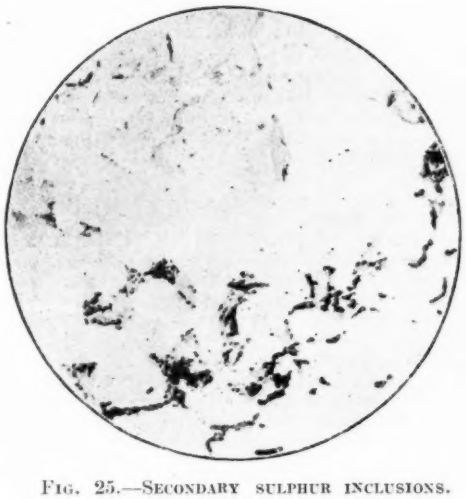


FIG. 25.—SECONDARY SULPHUR INCLUSIONS.

the fine reticular oxide strip. A remarkable fact is the deposition of the pearlite inwards, corresponding with the deposition of the oxide band. This shows that there is greater significance in the occurrence of the pearlite in the oxide strip than can be explained by the simple reversal of the reaction $2CO = C + CO_2$. Ferrous oxide is able to diffuse in iron but whether this diffusion takes place as the result of a certain degree of solubility in the solid iron, or by way of the gas phase, it is difficult to say. This finely divided ferrous oxide at the edge of malleable castings is probably the principal vehicle of decarburisation.

Open Contracts.

Bristol, July 31.—Construction of a bridge under the railway near Ashley Hill, Bristol, for the Great Western Railway Company. The office of the Engineer at Bristol Station.

London, W., July 31.—476 tons of steel girders and other iron and steel work of British manufacture, for the Great Western Railway Company. The office of the Engineer at Paddington Station.

London, S.E., August 2.—Chain, for the Director-General, India Store Department, Branch 14, Belvedere Road, Lambeth, S.E.1; weldless steel chain; steel tubing, lap welded or solid drawn; vacuum break gear.

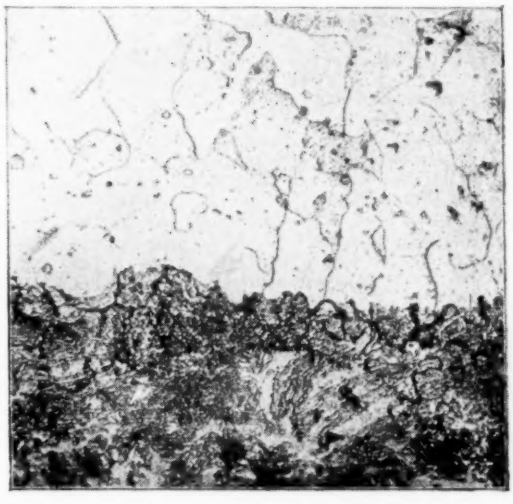


FIG. 26.—PEARLITE IN THE OUTSIDE LAYER OF THE SAMPLE MALLEABLISED AT 900 DEG. C. (×200 DIAS.)

London, E.C., July 31.—Bengal-Nagpur Railway Company, Limited, require 815 cast-steel axleboxes. The Company's Offices, 132, Gresham House, Old Broad Street, London, E.C.2 (Fee, £1 1s., non-returnable.)

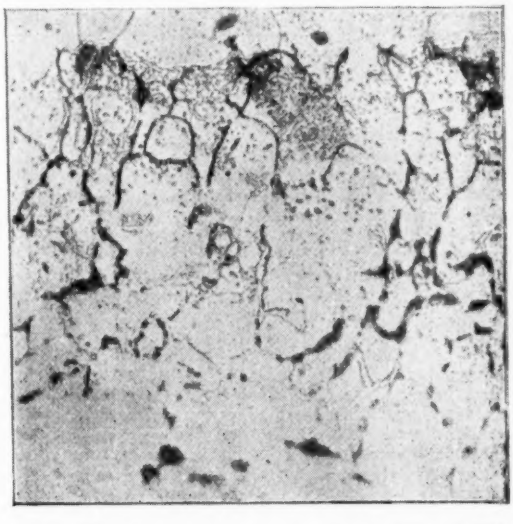


FIG. 27.—PEARLITE IN THE OUTSIDE LAYER OF THE SAMPLE MALLEABLISED AT 1,030 DEG. C. (×200 DIAS.)

Merton, July 27.—Supplying and fixing about 500 yards run of unclimbable iron railing, for the Merton and Morden Urban District Council. Mr. G. Jerram, engineer and surveyor, Council Offices, Kingston Road, Merton.

Corwen, August 17.—Construction of a storage reservoir and the providing, laying and jointing of about 1,000 yards of 6-in. and 3-in. water mains, for the Edeyrnion Rural District Council. Berrington, Son & Watney, Prudential Chambers, Wolverhampton, and 4, Memorial Hall, Oswestry. (Fee, £5 5s., returnable.)

XUM

Castings from a Machine-Shop Point of View.*

By C. R. Ormerod.

If foundrymen would consider the machine-shop view it might lead to their mutual advantage and be of benefit to the industry generally. Machine-shop men certainly had reason to consider the foundry, especially in regard to certain faults which they believed could easily be remedied. However, the author has only consented to give this Paper on condition that he obtained the assistance of one of his colleagues who handled castings to provide him with the information he required. That assistance had been readily given, and between them they had recorded certain kinds or types of faults with many examples. It was more the examples than the types of faults which exercised their minds, and the author's intention is to deal with some half-dozen of these castings as they passed through the machine shop and examined from the machine man's standpoint. While admitting that foundrymen had tried hard to improve their products, it was important to remember that these products had to be handled again. Foundry work was one of the few crafts left in which skilful and intelligent application of a man's knowledge was required and utilised to any great extent. In a machine shop, when a designer sent a job along, the question asked was "How many off?" Knowing the number, the machinist obtained the proper tools to hold the article, shaped it in the machine, and then said "Go ahead." But they could not do that in the foundry, he believed. Foundrymen had to exercise their skill in a way which the machine-shop men were not allowed to develop nowadays. For the latter the tools and cutters, jigs and templates were all made ready, so that they could scarcely make a mistake. Although great advances had been made during the last quarter of a century in harnessing the forces of Nature, the buying public demanded still further improvements. The designer, for example, who used his imagination, kept asking for more and more from the foundryman and machine-shop man.

Faulty Designing.

There never was a designer who did not make a mess of things, and he perpetrated more faults than anyone else in foundry practice. Material was now subjected to much greater stress, and was consequently held up longer. Moreover, the designer left no margin for safety if he could possibly avoid it. During the war, Government departments effected one thing which was not to the engineers' advantage, in that they went all over the country and mixed up their sources of supply. Indeed, this practice had so upset their blast furnaces and foundries that nowadays they scarcely knew what material they were receiving or where it originally came from. The foundry trade was, until then, in a somewhat similar position to the iron trade. When a foundry obtained a job, the specification was generally "in close-grained cast iron," if wanted for a wearing surface, then the manufacturer relied on certain houses for different kinds of pig, with the result that he could use certain mixtures and turn out a fairly good close-grained cast iron, and the engineers were moderately satisfied. A successful motor-cylinder maker had particular mixtures for every brand he was turning out. Steel manufacturers suffered from the same kind of thing. They used to be able to buy their raw material from certain blast furnaces which obtained their ore from one district, lime in another, and coke and other ingredients from other places. And they secured a material which was free from the impurities which they did not want, and contained a certain percentage of elements which they did require. Thus they obtained a steel of uniform grade, and could rely on turning out an article for a particular kind of work. But when the Government departments began to mix up this raw material, it was incumbent upon them to utilise the services of a chemist in order to ascertain what the mixture was and to blend it as required. However, good might arise, as metallurgists were learning how to blend everything, and in the end they would ascertain how to secure just what they wanted for particular purposes.

Cast iron was used extensively because castings made from it were easy to reproduce in certain forms, and could be easily obtained in suitable masses to absorb shock and vibration and give a finished surface. One great point was that it required little lubrication with fairly high temperatures, and did not tear up under friction like steels and other metals when subject to heat treatment, and, further, it was sometimes easy to machine. In non-ferrous metals, for instance, suitable shapes were obtained without difficulty.

Cylinder Castings in Machine Shops.

When a cylinder entered the machine shop, the first thing was to test it for porosity by water pressure. In this connection the author protests, as one accustomed to the use of cylinders, against the habit of putting them aside and allowing them to rust up. There were places in the cylinder where it did not much matter—generally at the bottom of the water jacket. If the piston did not uncover that spot, no harm need be feared, but in the cylinder head, where there were alternating heat stresses of considerable amplitude, the rust wore off in a very short time, and trouble resulted. The foundry did not get the blame for this, but the engine maker, who was made responsible for the piston being too tight. The charge against the engine maker was that the piston was not fitted properly, whereas the fact was, that the rust had cut in and *seized* up. Several cases which had been investigated were shown to be due to sponginess in cylinder heads, which he had discovered after subjecting the castings to the water test. Generally, there was a certain number of rejects, and the machine shop was fortunate to be free from them. If the machine shop was modern, the casting was fitted into the holding frame without unduly stressing any part. With cast iron, it was necessary to get beneath the sandy skin which the fettlers so kindly left on for the machinists to deal with. Although there were several operations, they need only last a few minutes, and it was the use of tools and the rent of the machines which sent up the cost, when machining conditions had to be adjusted and time taken up to prove that it was not sand which was enabling the casting to withstand the pressure test. A recent statement claimed that, in certain works, the first casting always turned out satisfactorily, but that they never knew what was going to happen afterwards. The author's firm had had similar experience with first castings, which allowed of some really beautiful work being turned out.

Valve-Box Castings.

A valve-box casting was sent to several foundries, but the first casting from it was invariably bad. Generally, the trouble was sponginess at the fillet in the boss, and, after two attempts, a large proportion were bad castings. There were cases when a little sponginess did not matter, such as in heavy base plates, heavy bed boxes, and the like, as these had not to hold liquids and had plenty of metal to take the weight. But in many castings, such as pumps, pump bodies, cylinder heads, and so on, sponginess was important.

Another trouble experienced was that, in taking off the skin, and very carefully drilling a cylinder, or machining a vent, for a heavy bed or surface plate, just as the machinist was progressing nicely, the "last" of the skin came off and revealed a large hole. However, even this did not annoy the machine-shop man nearly so much when he had all his tools set up—and it must be remembered that the setting-up cost more than the operation itself—and was hoping to get a number of articles properly machined, suddenly he came across a large hard lump in the casting, and, just as the particular tool was working nicely, its nose was snapped off.

* A Paper presented to the Coventry Branch of the Institute of British Foundrymen, Mr. G. E. Roberts presiding.

Streaky Castings.

This type of casting was somewhat unsuitable for motor engines, because, on testing the cylinders, it was sometimes found that the metal varied in density and hardness. This caused an uneven finish, and often severe wear of the tools. With only a few such castings in a batch, although the speed of working suited the majority, this fault of uneven hardness would cause breakages, and consequently a considerable loss of time, which added to the expense. Then the machine shop came across a good deal of scab on castings. The steel from which tools were made was expensive material, and the machining wore rather heavily on them. Hence they used them rather sparingly, and largely for cutting edges. Obviously, if there were defects in the casting, the points of these tools working on the plate were likely to go, which meant a job for the blacksmith, the hardener and grinder, and thus increased the cost of production to a considerable extent. However, he thought these defects were metallurgical troubles, and not the fault of the foundryman.

Making Jigs and Frames.

Jigs and frames were made to hold the castings so that everything could be produced as accurately as possible. It is necessary, however, that parts should be fitted together with the minimum of trouble. Jigs were made very strong, and the holes into which the tools were fitted for guiding purposes were also very rigid, so that the greatest accuracy should be maintained in successive castings undergoing similar operations. Sometimes it was almost impossible to get the castings in the jigs when they were bent or twisted. At other times, by off-setting them, they could manage to get the castings in position for machining, but when the holes came to be used afterwards, through having the thin wall on one side and the thick one on the other, distortion was set up and upset the running of the machine. And, although to the inspector who examined the machine, everything seemed to be in order for trimming and position, the trouble developed and often caused many hours of investigation. This difficulty was all the worse, because the mechanic did not generally look for this particular defect at first, but for something which was not done in the machine shop.

Another trouble which they had to contend with was in regard to loose heads in the valves in engine work. In connection with water jackets, sparking plugs and bosses, the valves were cut in the head and found to be twisted. Cutting the castings in two, they found that the moulding box had been parted correctly at the centre, and holes were left for the water to circulate round the sparking plug parts; but just above through the valve seats at the middle there were little steam pockets, formed because the water could not circulate. The designer, of course, ought to have made larger holes, so that they could see into the water jacket; but he could not do that on account of other big holes for something else. That, of course, was faulty design. When the mechanic came to jig castings, his object was to distort them as little as possible. For motor-car and aero work, it was essential to keep everything as light as possible in weight. At the same time, they were obliged to make what he might describe as fairly deep castings for crank cases, but it was found that, when the mechanic came to place them on the jigs or in the frame, the warping was so great that it was impossible to take out the amount left for machining. If a casting was desired parallel and to be machined both sides, the author did not know why such examples were sent in as those which were hardly strong enough to hold the weight on one side, whilst there was plenty of room on the other; nor did he know why they should take such curious shapes, because some were perfectly good and others were all askew.

Poor Quality Malleable.

Malleable iron has not been mentioned, because the author is afraid that its producers are going "to be left." Of course, there are some establishments which could not do without them, but so long as the malleable people continued to leave hard lumps in the middle of castings, which crushed the machine-shop drills, they would find it rather hard to give them a job.

Rejected Castings.

It appears to the author that, taking his own shop and ascertaining the percentage of castings rejected, he might be able to make out a good case for more consideration towards the machine-shop men by the foundry. However, by taking two or three firms, whose accounts are reliable, and asking them to supply the percentage of castings returned, it was found that they were really serious. The author believes that the results are fairly representative of the returned castings in Coventry. Castings which were made as some foundries required them for inside limits, or rejected to suit their jigs, were not included. It was found that cast iron was represented by 10 per cent. rejects, phosphor-bronze 2½, aluminium 10, cast-iron cylinder heads 9.7, cylinder plugs 16.3 (some as high as 25 per cent. to 30 per cent.), piston plugs 15, valves 1.8, other castings 4.5. Amongst other figures were phosphor-bronze gears and pump bodies, 4.6; oil-pipe joints and T tubes, 0.4; aluminium core boxes, 7 per cent.—even in aluminium, castings such as fans could reach 14.1 per cent. Buyers usually allowed for 25 per cent. of scrap, and in the machine shop operations are timed so as to carry the least amount of stock, so that all orders could be delivered to the factors of manufacturers the moment they required the goods. If material was allowed to lie about, it was merely capital lying idle, because overheads were still being paid and space was being occupied which could be put to better use. The object of the capable works manager was to keep everything moving in a constant stream. It was well to realise that, when they had this amount of scrap allowed, it meant that not only did the machine-shop man prepare for that amount, but that he had 25 per cent. more metal on his machine to deal with.

Obviously, if the foundryman sent castings to the machine shop in as good a condition as they could reasonably be made, it should be pointed out that, if the machinist was to cover that percentage, then the available plant had to be sufficient to accommodate it. But if they could eliminate that 25 per cent. of scrap, then the cost of a car, for instance, could be reduced considerably, because the percentage on the cost of castings was reflected all along in the cost of the car. Figures could be quoted to show the divisions of population according to the income earned, and that, by reducing the price of the car a little and bringing it into a category which made a larger market for it according to the greater population, they practically doubled their market. Whatever they could do to reduce the cost of a car, or to protect or increase the size of their market, would more than pay, because primarily their manufacturing expenses would decrease, while such expenses as advertising and sales expenditure would remain practically the same whether a firm sold 1,000 or 3,000 cars.

DISCUSSION.

The BRANCH-PRESIDENT (Mr. G. E. Roberts) thought the day when the malleable industry would cease was no nearer than when he first heard that prediction. But what surprised him was that buyers were prepared to concede to stampers and other firms supplying substitutes for malleable castings, certain points which they declined to concede to the malleable foundries. Take a job like a pulley, in which there was a hollow groove which could not be cored out on a stamping. Although it would facilitate the production of such castings if that pulley groove was left solid in the malleable, the buyer demanded that groove in the hollow, whereas, if it bought a stamping, it was solid. He maintained that, if the buyer took up that attitude with regard to matters of that kind, he was dealing very unfairly with what was called a dying industry. However, in spite of that, during the last two years in Coventry the malleable iron foundries had increased 40 per cent; he did not say the output had increased to that extent. He considered that the foundry still had a grievance against the machinist, and gave an instance. He supposed that, for the purpose of foundry tackle, they required a job machined to perfect accuracy. Out of 100, the machinist would scrap half-a-dozen castings before he turned out a perfect job, which they could use as a well-jointed job on their plate or box-making tackle. At the same time, he ex-

pressed appreciation of the refreshingly candid remarks of the lecturer.

MR. ELLIS, referring to cast-iron pistons, said he was aware that, for motor-car work generally, the sections were fairly thin, but complained of the hardness of many of the castings. Sometimes they would receive a batch of castings which would machine perfectly well, but other batches would be porous and hard, and they could not touch them with a file. Why were castings sent out in such a state?

Closing Blow-holes.

MR. F. H. HURREN, A.I.C., considered that the lecturer had let foundrymen down lighter than he had expected. There were one or two points to which he desired to refer. One was in regard to rusting up holes in cylinders. Unfortunately, he had found it impossible to rust up any fair-sized blow holes in cylinders so far, and if the lecturer had come across any examples, he should be very glad to hear of any particulars. However, they had found it possible, if the cylinder on a water test was liable to weep, that by putting it aside for a week or ten days, on re-testing, no further weeping took place. If that was really what Mr. Ormerod referred to, he hoped that his experience was that cases of that sort were quite feasible. Allusion had also been made to expensive jigs and tools for machining castings, and in this connection he had a complaint to make against the average jig. They rarely found a jig made by a tool-maker or machinist but that it did not come against the part which had to be ground or had a variable core. Why could not a tool-maker produce a jig which, when set down, came against an integral part of the casting, so that they obtained fewer variables? He was repeatedly having this shown to him, and he was afraid he was very much like a voice crying in the wilderness, for the next jig made was exactly the same.

As to the first casting being a good one, this was possibly due to the fact that the original casting made from the pattern was usually given to an exceptionally good man, who would be told to make a good job of it. Probably twice as much money was spent on it at no profit whatever, and then, when the order came in, the work was done in the ordinary way of production, and perhaps suffered a little in consequence. He should like engineers to understand that, in foundry work, there was a multitude of variables in the production of castings. There were so many different circumstances arising out of the heats of metal, the different kinds of pig, variations in blast pressure, volume, temperature and cooling, as well as in sand and ramming up; in fact, one could go on enumerating these extraordinary series of varying circumstances almost the whole evening. On the other hand, all the engineer had to do was to put the casting in the machine and keep an eye on it while it went round. They might be surprised to learn that the foundryman, when pouring the metal, scarcely knew what was happening or what the resultant casting would turn out like. Moreover, foundrymen were not alone in turning out scrap. They were frequently asked by customers to weld up holes incorrectly drilled or to look at parts machined where they should not be, and this would not be the case unless machinists were prone to error.

More Co-operation Needed.

MR. C. DICKIN, M.I.M., expressed appreciation of the insight which the lecturer had given them into machine-shop work. He would like to point out that an engineer, when he had passed through his period of training, was considered able to tackle almost any job. Yet it was possible for a man to live 200 years in the foundry trade and still find much to puzzle him, because there were so many difficulties and, as Mr. Hurren had said, so many varying circumstances. It was possible for a man to set out to make a mould which appeared to be perfect, and yet find that the resultant casting was waste. Take a four-bore water-cooled cylinder; if a speck of sand the size of a pin's head went down the runner, it could also cause waste. In many instances the conscientious moulder would strip his mould under such apparently small, but possibly very injurious, circumstances. Water-cooled cylinders in a modern foundry were tested to 60-lb. water pressure. So far as sweating or weeping was concerned, by putting a mixture of sulphate of iron or salamoniac in, they could sometimes form "a rust up," but that was only in cases of slight porosity. He rather agreed with the lecturer as regards design. It was nothing new to have a 3-mm. outside wall with bosses of 1⅛ in. or 1¼ in. diameter. He wondered whether it was thought possible to get a thorough combination part in 1¼ in. dia. with such thin sections as 3 mms. The metal which would suit one would not suit the other. As to Mr. Ellis's point about hardness, perhaps he might explain that, while no doubt metal was put in the cupola in order to obtain a soft casting, it was not uncommon for pistons with thin walls on either side of the section sometimes to get a shade of hardness.

So far as jig and tool designers were concerned, how many approached the foundryman and asked his opinion as to the running of the castings? Mr. Dickin explained that four-bore water-cooled cylinders sometimes had to be scrapped because, when a small speck of sand became stuck on the mould, the moulder had attempted to remove it with his finger. He thus caused some pressure, which left a swollen part on the cylinder of the mill, and, as the temperature lowered, this might cause a hard place. It was also a fact that they could not cast all water-cooled cylinders at the same temperature. Scabbing was not a metallurgical error, but caused in the moulding process either through ramming up too hard or through the sand being too wet.

Price Factors.

MR. G. H. JUDD considered that it was likely to do foundrymen good to hear complaints from the machine shops. As regards cylinders, they were a cast-iron job, and buyers were pretty well agreed that cast-iron jobs should be cheap, although cylinder work was one of the most intricate portions of the motor-casting industry. He might mention that instances were not infrequent in which customers actually took patterns away because they were quoted 10s. or £1 more to turn out as a first-class job against second-class work. He might point out that £1 per cylinder was only £1 extra on perhaps a £500 car, and consequently it seemed to him rather a poor and unsatisfactory policy all round to insist upon the lower-priced article, seeing that the cylinder was the most important part of the car. To a certain extent, he believed that this practice accounted for some of the troubles with regard to iron castings; they had to be made cheap because they were of iron. During the last few years he thought the foundry had had a little more voice in the designing, in the sense that pattern-shops and designers had met foundrymen by modifying their designs. When they came to deal with fillets or thicknesses, these modifications had certainly produced better castings than were obtained before. As to the hardness complained of, no doubt it must be very galling to machine hands in working a casting to come across white-heart castings or hard spots, because it was a very expensive item to re-set up machines through meeting these spots.

Another point which foundries were up against, apart from metal troubles, was to cure these hard parts from a metallurgical point of view. So far, unfortunately, this achievement was not yet in sight. What suited one machine shop did not suit another, and foundries as a result had to run various mixtures. Some of them did try to suit various machine shops for the peculiar type of castings they required. They had to work out standards for different firms, and consequently, as those conversant with cupola practice knew, there was often an overlapping of charges, and they could not always get just the hardness—it was perhaps either a little harder or softer—they required. Hence sometimes the hard metal passed into certain shops and the softer metal into others, when what was wanted was something between the two. Speaking of cylinder head trouble, where the flash was left in, Mr. Hurren said that, however intricate the design was, surely there were ways and means of examining the casting in machine shops by lamps and tapers to find out if the flash was actually left in.

Defective Inspection.

MR. ELGIE suggested that he might take it that, as very little was said about pattern-making from the makers' point of view, everything was correct.

He also remarked that very often, after spending hours in machining a casting, they found that at the final operation blow holes revealed themselves, hidden under the sand or skin. He suggested that if there were men in machine shops who understood how castings were made to examine castings, they would know where to look for blow holes and other defects, and they could certainly ascertain by means of a centre punch and hammer whether castings were porous or not. It was waste of time to go on repeating an error, and putting a casting through four or five different operations, only to find a defect in the same place every time.

MR. MAYFIELD said that he had expected that the foundry people would have been able to tell them that they could do better, but it appeared that they were all equally bad. As a matter of fact, when they received castings from the foundry, they had no real testing or inspection, and their feeling was that the foundries ought to do this for them. As things were, they placed the castings on the machines and started work, and then, when they seemed to be proceeding smoothly, they came across these defects. He understood several foundrymen to say that they could not turn out castings which were consistent, and so he supposed they must put up with it, but he hoped that there was some method of correction which would enable the foundries to give them more consistent castings. Of course, anyone would know by looking only under the skin of the matter that foundrymen had plenty of trouble, but when they came to consider the question of the consistency of metal, that was another point altogether.

Origin in the Machine Shop.

MR. DICKIN observed, in respect to the inconsistency of metal, that very often the turnings from the machine shops—high-speed steel, wrought-iron stampings and other scrap—were put on a dumping heap, and blast furnaces sometimes bought this kind of material. What, therefore, could they expect as regards the quality of pig-iron under such circumstances?

The PRESIDENT supported Mr. Dickin and Mr. Ashmore as to the rubbish bought by the blast furnaces, and said there was no doubt that a good many of the troubles in the foundry were due to the variables in the pig-iron.

MR. HURREN, referring to the particular casting (a valve box) on the table, said it might be stated that foundry work was largely a question of trial and error. They might start on right lines, but perhaps the first lot did not come out right; then they did something which they thought ought not to be done, and the result was often a good job. The man who never experimented never made any progress, even if he made no serious mistakes. One of the things which they might classify was in regard to bad design. As to variables in castings made in sand, he would point out that sand joints entailed a slight rise of sand which might make a difference of 2 or 3 mm. to the casting in the machine shop. Foundry work could never be made to exact limits, although at the present time it was much closer than the millwright's work. As to flash and the stopping of the water passages, his firm made a cylinder head with 33 separate cores, and the casting only weighed 37 lbs., yet no complaint was received about it. In every one of those 33 cores there was a chance of flash at the joint; and, moreover, they could scarcely have a large number of cores like that to come close up to one another absolutely true. In addition, naturally, the moulder liked to leave plenty of clearance. Even under the most careful preparations, they could not put two cores together without leaving a slight space between. Generally, flash was due to the fluidity of the metal from which the casting was made.

The Author's Reply.

MR. ORMEROD, in reply, said he could not handle all the points raised, but he certainly appreciated the difficulty of the many variables they as foundrymen had to deal with. It was for that reason that he mentioned the Government departments. He had been under the impression, however, that the metallurgist and foundryman were working so well together that the industry had come almost to control production. He might say in reference to the President's remarks on the grooved pulley, that when the machine-shop men worked on malleable castings they frequently broke his drills. If they could provide them with castings malleable all through, so that the castings could be machined as easily as stampings, and if the prices were also as competitive as those for stampings, he did not think that Mr. Roberts would have much difficulty in passing his product on. He believed one or two foundries made a practice of grinding the face of castings in order to obtain well-fitting joints. As to Mr. Hurren's remarks on rusting up, he had done a fair amount of it himself. One firm he was associated with had considerable trouble with their engines, and he found it was solely due to weeping. Rusting up did not matter under certain conditions. If they were to rust up where combustion took place, the temperature was so great that one could take any style of engine, and in five minutes the head could be melted out and washed away. The rust broke away, he said, in explaining the operation by diagram, and they gradually had water there, with the result that the cylinder functioned rather better on account of the small drops of water becoming turned into steam. When the steam cooled down, the temperature helped the expansion stroke and kept down the terminal temperature at the sides of the valves, the cylinder thereby becoming more efficient for a short time until the porous part allowed sufficient water through to rust. This rust, as he said, worked down the piston, and when the engine had been out a couple or three months in the customer's hands the piston seized up. A point had been made of putting a good man to turn out the first casting. This plan used to be followed in the machine shops. A capable man was kept for special jobs who would arrange the work so that the best men should deal with it. In England to-day they were suffering from a scarcity of really well-trained men. America had suffered from the same thing for several years, and that was one reason why he did not think it was good for us to copy American methods. In America they tried to train the few; in England they had in the past tried to train more, and that plan should be continued. What he particularly advocated was the training of their best men so that they could think out a job and its method of production. They should then be able to place different jobs in the care of certain men who could be relied upon to do what was required, and unskilled labour could do the rest of the work. They all realised that foundrymen were among those who had to figure out their jobs, and he had been inclined to think that, as they were aware of varying conditions, they were able to meet them. However, after what had been said, he was afraid he had entertained too high an opinion of what foundrymen actually could accomplish. He must confess that he did not realise that metallurgical problems were so difficult to solve, and it was certainly news to him that machine scrap which included wrought iron went to the blast furnaces. He should have thought puddlers would have paid more; he knew some who had obtained a lot of metal from Belgium, and understood that they were making bar iron. He could not say what the extra percentages of sulphur and phosphorus were that were going into iron now. During the war a little did not matter; the percentages were rather increased then, and he wondered whether this had any influence on the material they were now getting, seeing that ores were being used which were previously discarded. Mr. Dickin had helped him considerably, and he had his sympathy in the troubles which faced him. But hard lumps in castings were an expensive matter, and it would be a good thing if the ingredient that caused them could be cleared out. He suggested that perhaps manganese, which steelmakers were fond of using, was the cause. Mr. Judd accused them of buying in the cheapest market. But the cheapest market was not always equivalent to the smallest price. Buyers were watched by the people above them, and although a buyer might go into a low-priced market, if the results were not satisfactory, he would soon be turned off. The machine shop soon made itself heard, but, apart from that, the waiting period during which a job was sent overhead to be looked over meant a dead loss. Though a buyer could not afford to purchase scrap for his

firm, yet at the same time the management would not pay a big price. Inspectors at his firm did look for flash, but in the particular case he referred to it did not appear so bad. One man they consulted said it was due to sand, and advised "get a bit of wire," but it was only when the casting was cut in two that the real trouble was found. He agreed with Mr. Mayfield that castings should be overlooked at the foundry, and said it was evident that in some instances they were. Most of those he had mentioned, when they came to the machine shop, suffered from the "small pox" on account of the centre-punch marks on their surface, so that what the machine shop did was to carry the inspection a little further. He thought that, by these chats, foundrymen would appreciate the troubles of the machine shop better, and vice versa, and such an understanding should lead to improved results. In conclusion, Mr. Ormerod mentioned an electrical engineer's shop where most of the work was in copper, and said a scrap casting was very rarely seen there. He certainly thought a little more might be done to produce good castings, but recognised that the foundry trade laboured under unusual conditions in that, in the process of manufacture, the physical and natural factors altered from hour to hour and day to day, and did so in a way which our present scientific knowledge did not enable them to cope with as they cropped up.

Book Reviews.

How to Organise and Conduct an Export Business. By R. Osborne. Published by Messrs. Effingham Wilson, 16, Copthall Avenue, London, E.C.2. Price 4s. net.

One is always prone to imagine that once an order can be obtained, a method will be found to deliver the goods, even though the order is received from the furthest corners of the earth. This is largely true, but an advance knowledge of how export business is conducted may be direct help in originating business. The book under review sets out the business by giving numerous examples, which are easy to follow. Though practical foundrymen are usually not much concerned with what happens to their castings when they have left the foundry, the study of this book should help them if they set up in business for themselves. Most of the examples given refer to the textile business; we therefore presume that the export of machinery follows exactly the same routine. We believe, however, the book would be more interesting if some notes on how to deal with foreign custom-houses were included.

Industrial Furnaces. Volume I. By W. Trinks, Professor of Mechanical Engineering, Carnegie Institute of Technology. Published in England by Messrs. Chapman & Hall, 11, Henrietta Street, London, W.C.2. Price 22s. 6d. net.

The British edition of this book, as with most American books of this type, would be improved by using the centigrade scale in place of Fahrenheit. Beyond this criticism, however, we have nothing but praise for the book.

The book is a prime use to designers of furnaces and to metallurgical engineers specialising in this direction or making calculations as to the efficiency of existing or proposed furnace plant.

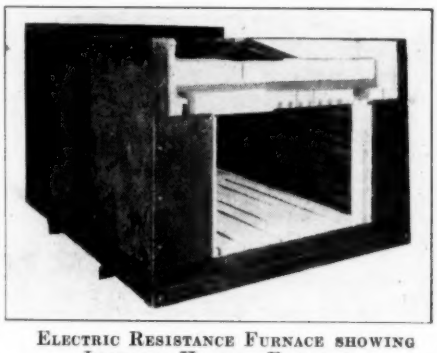
The more one reads of American refractories, the more one becomes obsessed with the idea that there are factors operating which make their conclusions totally different from British observations. For instance, the author says, on page 190, that, "Taking the amount of spalling of average first quality firebrick under severe conditions of heating and cooling as unity, the spalling of silica bricks is about fifteen, magnesia bricks thirty and chrome bricks ten. We feel sure that under British conditions magnesite would be found to spall less than silica. However, with good bricklaying and careful initial heating up of a furnace, spalling should not be a serious factor in furnace practice.

Unfortunately, in Volume I., no real space is devoted to cupola efficiency, and we suggest that in order to make the book of real interest for all English-speaking foundrymen, that the author will work out in detail a typical example. Another subject promised in the second volume is electric furnaces. It would be most interesting to have Professor Trinks' reasoned views of the relative efficiencies of conductive and non-conductive electric furnace hearths. We gather that the system of making electrically conductive hearths has not been a conspicuous success in the States, whilst in Europe at least no disadvantages are now found. This again brings us to the apparent different behaviour of refractories there and in Europe. We congratulate the author on having dealt with a subject which has been somewhat neglected since the time of Siemen's and look forward to the appearance of Volume II.

Furnaces with Internal Electric Heaters.

The demand for very large electric furnaces, both in the ferrous and non-ferrous trades, has increased, but the problem presented many technical difficulties, which, however, have been successfully overcome. Automatic & Electric Furnaces, Limited, 173-175, Farringdon Road, London, E.C.1, construct their resistance furnaces on the unit principle, with inside or exposed heating coils. Each unit consists of a brick measuring 4 in. × 4 in., shaped so as to dovetail into its neighbours, and in the face of each unit or brick are three annular channels.

When these bricks forming the heating chamber are assembled, the annular channels, as indicated in our illustration, present continuous grooves in the walls, floor and roof, and the heating units in the form of spirals or rods are drawn through from end to end of the heating chamber or tunnel.



ELECTRIC RESISTANCE FURNACE SHOWING INTERNAL HEATING ELEMENTS.

The grooves in which the heating elements lie are shaped so that the heaters are free to expand in all directions, but are prevented from coming into contact with work in the furnace, as the longitudinal opening of the groove is smaller than the diameter of the heating element.

As an indication of energy consumption, it may be stated that a furnace measuring 20 ft. × 12 ft. high and 12 ft. wide requires 1,400 kw. per hour to maintain a temperature of 1,000 deg. C., but the same size furnace for non-ferrous annealing at, say, 500 deg. C., requires only 490 kw. A carburising furnace of the same construction, measuring 24 in. × 12 in. × 12 in., is heated in one hour to 900 deg. C., with a consumption of 11 kw., and the furnace after the first hour, together with work being carburised, is maintained at 900 deg. C. with a consumption of only 5.6 kw.

THE RECONSTRUCTION SCHEME to be submitted to the debenture and shareholders of Sheffield Steel Products, Limited, on July 27, involves a reduction in the capital of more than two millions. The £1 preference shares are to be written down to 10s. each, and the £1 ordinary shares, of which there are now 1,730,700 issued, to 1s. each. The capital will then amount to £450,035, against the present figure of £2,457,701. The arrears of preference dividend are to be cancelled, and the dividend reduced from 10 per cent. cumulative to 5 per cent. non-cumulative with a participation in surplus profits.

Trade Talk.

AUGUST'S MUFFLE FURNACES, LIMITED, King Cross, Halifax, have received an order from Davy Bros., Limited, for the complete drying plant for their new foundry at Darnall, Sheffield.

LICENCES UNDER THE Non-Ferrous Metal Industry Act have been granted by the Board of Trade to J. Bowes & Sons, Goschen Street, Grosvenor Street, Camberwell Road, London, S.E.5; The Cambrian Electrolytic Zinc Company, Limited, 80, Bishopsgate, London, E.C.2; and Tonks & Pendleton, 16, Herald Chambers, 28, Martineau Street, Birmingham.

PRINCEPS & COMPANY, engineers, Wentworth Chambers, Pinstone Street, Sheffield, have appointed the following agents:—London: Mr. A. Stewart Mumme, Hopetoun House, 5, Lloyd's Avenue, E.C.3; Newcastle-on-Tyne: Lindsay & Ward, Pilgrim Street; Manchester: Mr. H. F. Southern, 83, Millgate Buildings, Long Millgate.

The percentages of unemployment among insured workpeople in the iron and steel trades of Great Britain at the end of each of the last six months for which figures are available are as follows. SIR M. BARLOW has informed SIR F. KELLEY:—December, 1922, 24.3; January, 1923, 22.1; February, 1923, 18.6; March, 1923, 16.7; April, 1923, 16.8; May, 1923, 16.3.

According to VISCOUNT WOLMER the value of iron and steel and manufactures thereof imported into Great Britain from the countries specified during the first five months of the current year is as follows:—From Germany, £799,672; Belgium, £2,299,481; France, £726,951; United States, £660,475. In these aggregate figures, the particulars for January-March include, while those for April and May exclude, goods imported direct into the ports of the Irish Free State.

IN THE MONTH of June three vessels, of 11,177 gross tons, were launched on the Tyne, an increase of one vessel and 2,078 tons over the corresponding month last year. In the first six months of this year 30 vessels, of 91,820 tons, were put into the water, as compared with 16 vessels, of 87,658 tons, in the corresponding period of last year. At the end of June there were 88 vessels, of 92,153 net register tons, laid up in the Tyne, as against 97 vessels, of 101,710 tons, at the end of May.

Gazette.

THE EYNSFORD ENGINEERING COMPANY, LIMITED, are being wound up voluntarily.

THE CREDITORS OF the Atlas Equipment & Engineering Company, Limited, met at 7, Hanover Square, W., on Monday, July 23.

MR. J. DAVIE, 3, London Wall Buildings, London, E.C.2, has been appointed receiver and manager of Gwynnes Engineering Company, Limited.

TRADING under the style of Higgins Brothers, Messrs. J. A. Higgins and G. F. Higgins, Regent Engineering Works, Hay Green, Lye, near Stourbridge, engineers and ironfounders, have dissolved partnership.

NORMANBY IRON WORKS COMPANY, LIMITED, Middlesbrough.—It has been resolved and confirmed that the company be wound up voluntarily, with Mr. A. W. Gow, Royal Exchange, Middlesbrough, C.A., as liquidator.

TRADING under the style of Aitken & Company, Messrs. H. W. Aitken, J. Shearer and W. Sommers, Britannic House, Park Circus, Glasgow, colonial engineers, merchants and exporters, have dissolved partnership. Messrs. H. W. Aitken and J. Shearer continue the business.

G. L. GRACE and T. H. G. Childs, Middlewood Cottage, Oughtibridge, metal merchants, late trading as Grace & Childs, Howard Chambers, Norfolk Street, and 19, North Church Street, Sheffield, have been adjudicated bankrupts.

W. M. WARMAN (described in R.O. as W. M. Warman), 152, Westgate Road, Newcastle-on-Tyne, late 37, Tooting Bec Road, and Balfour House, Finsbury Pavement, E.C., metal broker, has been adjudicated bankrupt. (Amended notice.)

MR. J. SWALES, 1, Clarence Street, Redcar, and 252, Newport Road, Middlesbrough, scrap iron merchant, has been adjudicated bankrupt. First meeting, O.R.'s, Stockton-on-Tees, July 27, at 2.15. Exam., C.C., Middlesbrough, August 10, at 10.30.

THE PETITION FOR confirming the reduction of the capital of Kitson Company, Limited, from £400,000 to £335,000 will be heard before Mr. Justice Russell on July 24, 1923; and that for the reduction of the capital of Cubitts Engineering Company, Limited, from £600,000 to £249,728 6s., before Mr. Justice P. O. Lawrence on the same date.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Railway Chairs.

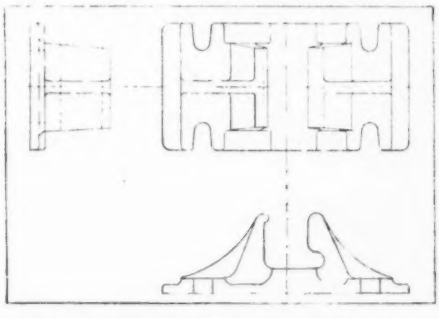
To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Now that the railways have become more consolidated, I believe there is a desire to become more standardised, and one of the items which is receiving or has received some attention is railway chairs.

From a foundry point of view, this class of casting has nearly always been a problematical line, their use being so extensive and the desire to minimise their cost so acute that men have had to exercise their efforts considerably to cope with these difficulties, to the extent that the moulder making them has been reduced to more or less a human machine. The work of making them has been very laborious, and the pay (nearly always piecework) has not always been very remunerative.

Furthermore, the designs of chairs in the past have not been of such a character as would commend them for machine moulding, the hand methods having been brought up to such a fine point that machines were not capable of improving the output or reducing the cost.

Now that there seems to be a hope of developing some uniformity, I herewith submit a design of a railway chair which appears capable of bringing them within the scope of the split pattern moulding machine without impairing their utility.



Previously the necessity for having so many loose pieces to obviate coremaking has not been helpful from a machine point of view, but it will be noticed that instead of having round holes for spiking to the sleeper, I have shown four slots, and to all intents and purposes I see no objection to the adoption of this principle. The chance of movement will not be increased, but with four spikes the chair would be made more rigid than can be the case with chairs having only two spikes, and there are many of this style in use.

It will therefore be noticed that by the introduction of spiking slots instead of holes, it will allow for the pattern being made in halves, two of which can be mounted on a machine pattern plate and top and bottom boxes made without changing anything on the machine. By such an arrangement, greater output at a reduced cost should be a very reasonable possibility.

If this idea should not be found acceptable, possibly it may lead to some effort being made to reach the object aimed at by some other method.

Yours, etc.

J. J. MCCLELLAND, M.I.M.E., M.I.B.F.

1, Witham Road, Osterley.

July 21, 1923.

The "Fescol" Process.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We have a copy of your notice *re* the "Fescol" process, which is in error:—

(1) The process is not an adaptation of nickel plating.

(2) The N.P.L. test was not carried out on a cylinder, but on solid steel, and this was screwed into a steel holder. There was no bushing, and the point was that at 17.6 tons to the square inch, the basic steel stripped not the nickel.

Yours, etc.,

3, Penarth Street, S.E.15. FESCOL, LTD.

July 24, 1923.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Conditions in the pig-iron market continue extremely unsatisfactory, the persistent decline in values so far offering little inducement to buyers, who are apparently convinced that quotations have not reached absolutely bottom levels, and who consequently decline to extend purchases beyond their immediate urgent requirements. Meanwhile, Cleveland ironmasters are in the difficult position of being unable to reconcile pig-iron values with the costs of production, of which the main factors, labour and fuel, continue at too high levels to prevent any substantial reduction in selling prices to consumers. Market movements are also further restricted by the approaching holiday season, and it is not regarded as probable that any change for the better can be anticipated much before the end of the quarter, and even this must be considered contingent on a marked improvement in the European political situation. The limited amount of business now passing is practically governed by current prices ruling at this week's Cleveland market, when sellers were still adhering to 105s. per ton for No. 3 G.M.B., but there was a readiness to shade this figure for any fair-sized parcels. No. 4 foundry was offering at 100s., and No. 4 forge at 97s. 6d. per ton. The output of No. 1 is very small, and moderate lots are negotiable at round about 115s. per ton.

It is significant that once again hematite has fallen to a figure lower than that of Cleveland foundry iron. The make of the latter is, of course, much more limited, and with the production of hematite so much in excess of present demand makers are keen to find an outlet, though with costs as they are this means considerable sacrifices. The only alternative is to damp furnaces down, and makers are very reluctant to take this step, though it may even be unavoidable unless there is a very marked change in the position. In this week's market East Coast mixed numbers were quoted at 102s. 6d. per ton, and this could be shaded for suitable business. The premium for No. 1 is 6d. per ton. Similar conditions are noted in the West Cumberland and North Lancashire hematite markets, Bessemer mixed numbers being quoted at £5 17s. 6d. delivered at Glasgow and Sheffield—a figure, however, which can be shaded to meet the exigencies of the situation, the general quotation ruling nearer £5 15s.

MANCHESTER.—Business in this market is now almost entirely confined to hand-to-mouth dealings, some of the ironfounders being practically without reserves of pig-iron, but owners and managers of foundries are confident that whenever they want iron for use they can get it at a moment's notice, and hence seem quite indifferent as to the state of their stocks. As experienced in other markets, some price-cutting in Lancashire is reported, although smelters claim that they have not gone below £5 at the Derbyshire furnaces and £4 17s. 6d. for Northamptonshire makes, but it is fairly well known that these prices have been shaded, and that 97s. 6d. and 95s. respectively have been taken. Meantime the demand for castings in this district does not seem to improve, and many iron foundries are short of work.

THE MIDLANDS.—Reports from this area are certainly a shade more promising than in other districts, inasmuch as resulting from a conference between consumers and producers coke prices have been fixed at 26s. This represents a considerable concession compared with some of the high prices ruling three months or so ago, but it still leaves the figure too high for practical purposes, and smelters will still have a difficulty in carrying on profitably. In South Staffordshire also there is a somewhat better demand for foundry iron, although by no means so active as could be desired. Naturally with conditions so generally unsatisfactory prices are somewhat irregular. One or two makers seem to be endeavouring to maintain their quotations firmly, but others will consider reasonable offers, and seem ready to make concessions to old and well-liked customers. The prices obtainable are unsatisfactory, but on the other hand probably the accumulation of stocks would be worse in the long run, because everyone seems to be looking forward to lower levels sooner or later. Quotations:—Northamptonshire No. 3 foundry, 97s. to 100s.; Derbyshire No. 3 foundry, 100s., net f.o.t. furnaces.

SCOTLAND.—Works throughout the district having closed down for the annual holidays, business in the Glasgow pig-iron market is practically suspended, but conditions generally are far from satisfactory. Several furnaces have recently gone out of blast, and it is feared if no improvement is experienced shortly other plants will also be damped down. Makers complain that prices of pig at current levels are unremunerative, and with the decline in export trade there is now no ready outlet for production. Meantime, No. 3 Scotch is quoted at £5 8s. 9d. at the furnaces, whilst No. 3 Middlesbro' at Grahamston is £5 13s. 6d. The latter is still out of line in comparison with Scotch, consequently the buying of Middlesbro' is very restricted. There is some No. 3 Continental foundry being offered at £5 5s. at Grahamston, but there is very little iron coming forward.

Finished Iron.

The depression existing of late in most branches of the finished iron industry continues unabated, and both at home and for export demand has been for some time in much diminished volume. These conditions are, however, by no means unusual at this period of the year, but even making allowance for the falling off of seasonal demand, works are exceptionally short of orders, and many of the mills and forges are either closed down or only partially employed. In marked bars fair trade is being done, but under no pressure.

Steel.

There has been no perceptible improvement in the steel market, which continues without movements of any outstanding importance. Production does not appear, however, to have been greatly cut down at present, and the fact that stocks are being added to suggests that it is anticipated that the period of slackness will not be very protracted. It is stated that soft billets are being sold below cost, and although quotations are unchanged prices are sagging. The demand for basic steel has dwindled almost to nothing. Crucible and alloy steels show a slight improvement, though the volume of business transacted is by no means large. So far as ferro-alloy prospects are concerned, the outlook is a little brighter, and a period of firmer prices is approaching, but for the moment not much change is shown. With the holiday season over, and the autumn coming along, advances are certain to take place in several directions, as, for example, ferro-silicon, where price in 45 per cent. has eased off somewhat, due to the absence of business and the desire to unload old stocks of this notably poor-keeping alloy. The condition of the tinplate market is unchanged, and business is very slow. The tone is unsatisfactory, and many pessimistic views are being taken. What little fresh business is passing is still at the official minimum of 23s. 1½d. basis, I.C.

Scrap.

Markets in all the principal centres of the scrap metal trade give evidence of increasing weakness, the stagnation in the foundry industry, especially having a depressing effect upon business in this material. In Lancashire, dealers find it difficult to obtain purchasers except for retail quantities, even for cast scrap at 80s., unless for best quality textile machinery material. For common cast scrap also 80s. is usually quoted, but less would be taken. Probably a fair quotation for guidance would be from 75s. to 85s. per ton, according to quality; but even at these rates very little is being sold. It is, however, possible, if trade revived, that consumers would begin to buy more freely; but is there any chance of a revival in the foundry industry this year? The position of the iron foundries shows no improvement, and the demand for cast-iron scrap is greatly reduced. Heavy machinery metal and scrap railway chairs run about 90s. per ton, and ordinary heavy cast-iron scrap 10s. per ton less. Light metal and furnace firebars are about 67s. 6d. per ton.

Metals.

Copper.—The uncertainty of the political situation abroad, coupled with a less active demand for home consumption, recently had an adverse effect upon standard copper values, but this week the market has assumed a much stronger tone. The recent improvement has evidently led to profit-taking, and September-October and three months were freely offered. On the other hand, the outlet for manufactured copper has remained restricted, India maintaining an attitude of

reserve, but quotations in that direction are more firmly held. Reports from across the Atlantic were distinctly firmer, better buying having been experienced there at hardening prices, while the American statistical position is considered sound, and there is not much fear of any further increase in the domestic output, especially over the remainder of the hot season. Current quotations :—*Cash* : Thursday, £65 12s. 6d. ; Friday, £65 17s. 6d. ; Monday, £65 10s. ; Tuesday, £65 17s. 6d. ; Wednesday, £65 12s. 6d. *Three Months* : Thursday, £66 7s. 6d. ; Friday, £66 12s. 6d. ; Monday, £66 5s. ; Tuesday, £66 12s. 6d. ; Wednesday, £66 7s. 6d.

Tin.—Influenced by similar reasons as those affecting other metals, the market for standard tin also suffered a relapse in values, but in this case likewise the set-back was only temporary in duration, and this week's values are higher. The disturbed conditions experienced recently have produced a partial paralysis of trade, and the very hope of returning order is exercising an influence on sentiment, and—what is of immediate importance—on actual buying by consumers, which was reflecfed this week in the upward course of values. There is no justification for any runaway market, but the periods of political delay and disappointment may occur and result in passing weakness, and this happened during the previous week. On the whole, however, the outlook is less threatening, and there is a general disposition to believe that the worst of a protracted state of depression may have passed. Current quotations :—*Cash* : Thursday, £179 10s. ; Friday, £183 2s. 6d. ; Monday, £186 10s. ; Tuesday, £187 ; Wednesday, £185 5s. *Three Months* : Thursday, £180 15s. ; Friday, £184 2s. 6d. ; Monday, £187 12s. 6d. ; Tuesday, £187 15s. ; Wednesday, £186.

Spelter.—Values of this metal have been subject to fluctuations, but quotations on the whole have remained fairly firm. American advices of late have been strong, and point to a consumption in excess of production. Trade here, however, is very slow, and orders from consumers are as yet too small to maintain high values. Current quotations :—*Ordinary* : Thursday, £29 7s. 6d. ; Friday, £29 15s. ; Monday, £30 5s. ; Tuesday, £30 15s. ; Wednesday, £30 10s.

Lead.—The market for soft foreign pig has maintained a steady tendency, but business generally has been quiet. In view of the heavy arrivals during June and the small stocks now on hand, according to the official statement, it can only be concluded that lead has been put into private warehouse, as obviously it has not gone into consumption. Australian shipments last month were on the full side, and Mexican lead and ore is coming freely to Europe. Current quotations :—*Soft foreign (prompt)* : Thursday, £24 2s. 6d. ; Friday, £24 10s. ; Monday, £24 10s. ; Tuesday, £24 12s. 6d. ; Wednesday, £24 7s. 6d.

Company News.

Duzmo Engineering Company, Limited, 5, John Street, Bedford Row, W.C.—Capital £100. Permanent directors: Mrs. P. A. Wallace and W. B. Pearson.

Standard Brass Foundry Company, Limited.—Capital £7,000. Brassfounders. T. W. Lench, of Tregaron, West Hagley, near Stourbridge, permanent governing director.

Greenwood & Batley, Limited.—Profit, £24,160; brought forward, £20,768; total, £44,928; depreciation, £5,000; final dividend on ordinary shares, 2½ per cent., making 5 per cent. for year; carried forward, £15,480.

A. Deakin & Company, Limited, Victoria Ironworks, Walmgate, York.—Engineers. Capital £1,000 in £1 shares (400 6½ per cent. cumulative preference and 600 ordinary). Directors: A. Deakin, T. Parker and Mrs. E. Matthews.

Fanshaw & Shurmer, Limited, 63, London Road, Manchester.—Engineers. Capital £6,000 in £1 shares (2,000 6 per cent. cumulative preference and 4,000 ordinary). Directors: T. Shurmer, H. G. Braybrooke and C. H. Thomas.

Furness, Withy & Company, Limited.—Profits, including balance brought forward, £758,566; bonus, 2½ per cent., free of tax, on ordinary, making total dividend for year of 7½ per cent., free of tax; depreciation, £200,000; carry forward, £202,316.

Blackfriars Foundry Requisite and Equipment Company.—The partnership heretofore existing between Messrs. Harold Edward Ricketts and Francis James Barraball, under the style of the Blackfriars Foundry Requisite and Equipment Company, at 181, Queen Victoria Street, London, E.C.4, has been dissolved as from July 1, Mr. F. J. Barraball continuing to trade under the same name and taking over the goodwill, assets and trade debts of the old partnership. Mr. H. E. Ricketts has now rejoined Thos. E. Gray & Company, of 119, High Holborn, with whom he was previously associated for many years.

Telephone : 21, Penistone. Telegrams : "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING PLUMBAGO CORE GUM WHITE DUST COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	65	12	6
Three months	66	7	6
Electrolytic	72	10	0
Tough	69	0	0
Best selected	69	0	0
Sheets	100	0	0
India	88	0	0
Wire bars	73	0	0
Do. July	73	0	0
Do. August	73	0	0
Ingot bars	72	10	0
H.C. wire rods	78	0	0
Off. aver., cash, June	66	13	5⅜
Do. 3 mths., June	67	2	11½
Do. Settlement, June	66	13	8½
Do. Electro, June	73	10	4½
Do. B.S., June	70	16	8
Aver. spot price, copper, June	66	12	4½
Do. Electro, June	73	15	11½

Solid drawn tubes	13¾d.
Brazed tubes	13¾d.
Wire	10¾d.
Yellow metal rods	7¼d.
Do. 4x4 Squares	8¾d.
Do. 4x3 Sheets	9¼d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	13½d.
Rods, drawn	10½d.
Rods, extruded or rolled	7½d.
Sheets to 10 w.g.	10½d.
Wire	10¼d.
Rolled metal	10d.

TIN.

	£	s.	d.
Standard cash	185	5	0
Three months	186	0	0
English	186	0	0
Bars	188	0	0
Chinese	183	10	0
Straits	188	0	0
Australian	188	0	0
Eastern	190	15	0
Banca	188	10	0
Off. aver., cash, June	191	18	0¾
Do. 3 mths., June	192	7	7½
Do. Sttlment, June	191	18	4
Aver., spot, June	191	16	5¼

SPELTER.

	£	s.	d.
Ordinary	30	10	0
Remelted	29	0	0
Hard	25	0	0
Electro 99.9	35	0	0
English	31	0	0
India	27	10	0
Prime Western			—
Zinc dust	45	0	0
Zinc ashes	9	10	0
Off. aver., June	29	12	6¼
Aver., spot, June	29	10	11¼

LEAD.

	£	s.	d.
Soft foreign ppt	24	7	6
English	26	0	0
Off. average, June	25	2	1½
Average, spot, June	25	8	6¼

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	36	0	0
Do. V.M. ex whf.	36	10	0
Dutch	34	0	0
Rods	43	0	0
Boiler plates	35	0	0
Battery plates	35	10	0

ANTIMONY.

	£	s.	d.
English regulus	28	5	0
Special brands	34	10	0
Chinese	25	10	0
Crude	23	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
45/50%	£12 10 0
75%	£20 15 0
Ferro-vanadium—	
35/40%	16/6 lb. va.
Ferro-molybdenum—	
70/75% c. free	9/– lb.
Ferro-titanium—	
23/25%, carbonless	1/2 lb.
Ferro-phosphorus, 20/23%,	£27 0
Ferro-tungsten—	
80/85%, carbon free	1/5½ lb.
Tungsten metal powder—	
98/99%	1/10½ lb.
Ferro-chrome—	
4/6% car.	£22 10
6/8% car.	£21 10
8/10% car.	£21 0
Ferro-chrome—	
Max. 2% car.	£52 0
Max. 1% car.	£62 0
Max. 0.70% car.	£72 0
67/70%, carbonless	1/6 lb.
Nickel—99%, cubes or pellets	£130 to £135
Cobalt metal—98/99%	11/6 lb.
Aluminium 98/99%	£115–£120
Metallic Chromium—	
96/98%	4/3 lb.
Ferro-manganese (net)—	
76/80%, loose	£18
76/80%, packed	£19
76/80%, export	£20
Metallic manganese—	
94/96%, carbonless	2/– lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, tungsten	14% s. d. 2 6
Finished bars, tungsten	18% 3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. to 8 in. inclusive 4d. lb.

Rounds and squares under ½ in. to ¼ in. 3d. lb.

Flats under 1 in. by ⅛ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness 3d. lb.

Bevels of approved sizes and sections 6d. lb.

If in coils 3d. lb.

Bars cut to length 10% extra

Scrap from high-speed tool steel—

Scrap pieces 3d.

Turnings and swarf 1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	4	2	6	4	7	6
Bundled steel & shrngs.	3	15	0	4	0	0
Mixed iron & steel				3	15	0
Heavy cast iron	4	0	0	4	5	0
Good machinery for foundries	4	7	6	4	10	0
Cleveland—						
Heavy steel				4	0	0
Steel turnings				3	5	0
Cast-iron borings				3	5	0
Heavy forge				4	15	0
Bushelled scrap				4	0	0
Cast-iron scrap				4	2	6
Lancashire—						
Cast-iron scrap				4	0	0
Heavy wrought				4	0	0
Steel turnings				3	12	6
London — Merchants' buying prices delivered yard.						
Copper (clean)				56	0	0
Brass (clean)				36	0	0
Lead (less usual draft)				19	10	0
Tea lead				17	10	0
Zinc				18	10	0
New aluminium cuttings				75	0	0
Braziery copper				50	0	0
Gunmetal				47	0	0
Hollow pewter				150	0	0
Shaped black pewter				90	0	0

PIG-IRON.

N. E. Coast—	
Foundry No. 1	115/–
Foundry No. 3	105/–
Forge No. 4	97/6
Mottled	—
Hematite No. 1	103/–
Hematite M/Nos.	102/6
Midlands—	
Staffs. common*	103/9
„ No. 4 forge*	97/3
„ No. 3 foundry*	103/9
„ Cold blast, ord.	190/–
„ „ roll iron	200/–
„ basic	—

* d/d Birmingham district.

Northants forge	89/–
„ fdry. No 3	97/– to 100/–
„ basic	105/–
Derbyshire forge	90/–
„ fdry. No. 3	100/–
„ basic	105/
Scotland—	
Foundry No. 1	111/3 to 113/9
„ No. 3	108/9
Hematite M/Nos.	115/–
Sheffield (d/d district)—	
Derby forge	93/6
„ fdry No. 3	103/6
Lincs. forge	100/–
„ foundry No. 3	105/–
„ basic	110/–
E.C. hematite	112/9
W.C. hematite	112/6 to 115/–

All d/d in the district.

Lancashire (d/d eq. Man.) —	
Derby forge	—
„ foundry No. 3	106/
Northants foundry No. 3	—
Cleveland foundry No. 3	—
Staffs. foundry No. 3	—
Lincs. forge	—
„ foundry No. 3	—
Dalzell, No. 3	125/9
Summerlee, No. 3	125/9
Glengarnock, No. 3	125/9
Gartsherrie, No. 3	125/9
Monkland, No. 3	125/9
Coltness, No. 3	125/9

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.
Bars (cr.)	11 10 0 to 12	10	0
Angles	12	5	0
Tees to 3 united ins.	12	10	0
Nut and bolt	10	17	6
Hoops	15	0	0
Marked bars (Staffs.)	14	10	0
Gas strip	13	0	0
Bolts and nuts, ¾ in. × 4 in.	20	10	0
Steel—			
Ship plates	£9 15 0 to 10	0	0
Boiler plates	13	10	0
Chequer plates	11	5	0
Angles	£9 5 0 to 9	10	0
Tees	£10 5 0 to 10	10	0
Channels	9	15	0
Joists	£9 10 0 to 9	15	0
Rounds & squares 3 in. to 5½ in.	10	0	0
Rounds under 3 in. to ¾ in.	9	15	0
Flats, over 5 in. wide and up	10	5	0
Flats, 5 in. to 1½ in.	9	10	0
Rails, hvy	£9 10/- to 10	0	0
Fishplates	14	0	0
Hoops (Staffs.)	12	7	6
Black sheets, 24 g.	13	10	0
Galv. cor. sheets, 24 g.	17	15	0
Galv. fencing wire. 8 g. plain	18	5	0
Rivets, ¾ in. dia.	14	5	0
Billets, soft	£7/5/0 to 8	0	0
Billets, hard	10	0	0
Sheet bars	£8/0/0 to 8	15	0
Tin bars	9	2	6

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2¾
Sheet	1 4
Wire	1 4
Rods	1 2¾
Tubes	1 6½
Castings	1 1½

Delivery 3 cwt. free to any town.

10% phosphor copper, £40 above price of B.S.

15% phosphor copper, £50 above price of B.S.

Phosphor tin (5%), £30 above price of English ingots.

CHARLES CLIFFORD & SON, LIMITED, BIRMINGHAM.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/4 to 1/10
To 18 in. wide	1/4¾ to 1/10¾
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6½ to 2/0½
Ingots for spoons and forks	9d. to 1/3
Ingots rolled to spoon size	1/– to 1/6
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	28.26
No. 2 foundry, Valley	26.00
No. 2 foundry, Birm.	25.00
Basic	26.77
Bessemer	28.27
Malleable	27.77
Grey forge	27.27
Ferro-manganese 80% delivered	120.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y, at mill	43.00
Bess. billets	42.50
O.-h. billets	42.50
O.-h. sheet bars	42.50
Wire rods	51.00
	Cents.
Iron bars, Phila.	2.67
Steel bars	2.40
Tank plates	2.50
Beams, etc.	2.50
Skelp, grooved steel	2.40
Skelp, sheared steel	2.40
Steel hoops	3.15
Sheets, black, No. 28	3.85
Sheets, galv., No. 28	5.00
Sheets, blue an'l'd, 9&10	3.00
Wire nails	3.00
Plain wire	2.75
Barbed wire, galv.	3.80
Tinplate, 100-lb. box	$5.50

COKE (at ovens).

Welsh foundry	40/– to 45/–
„ furnace	30/– to 35/–
Durham & North. fdy.	45/–
„ furnace	36/6
Other Districts, fndy	45/–
„ furnace	26/–

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	23/1½
„	28×20, „	46/3
„	20×10, „	33/9
„	18¾×14, „	24/1½
C.W.	20×14, „	21/10½
„	28×20, „	43/9
„	20×10, „	30/6
„	18¾×14, „	22/4½
Terneplates	28×20, „	42/9